

Vegetation Management Plan

Saskatoon Island Provincial Park

May 15, 1999

Prepared by:

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Prepared for:

Alberta Environmental Protection
Natural Resources Service
Valleyview, Alberta

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Grande Prairie, Alberta

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Vegetation Management Plan

Saskatoon Island Provincial Park

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Audrey Wells	Floral inventory, field work

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Introduction

Background

This project is the initial stage in the development of a long-term management plan which will address the vegetation profile of the upland tall shrub and forest communities in Saskatoon Island Provincial Park. There is a concern that the deciduous woodlands and saskatoon shrublands are becoming decadent and may not be succeeded by healthy communities over the long term.

Overview of the park vegetation

Saskatoon Island Provincial Park is in the Peace River Parkland Subregion of The Parkland Natural Region (Natural Regions and Subregions of Alberta, 1992). As such it is a remnant area, since much of the natural subregion has been lost to cultivation (Figure 2). Archeological studies at Saskatoon Mountain suggest that prior to the arrival of the pioneers in the late 1800's, the Grande Prairie area was inhabited by aboriginal people for at least 9,500 years (Wright, 1992). Campbell (1975), states that, "Named for the abundance of saskatoon berries growing rank... 'Lake Saskatoon' Island had been a favorite summer camping site for generations of natives long before the advent of turn-of-the-century settlers."

Today, the forested area of the park covers about 40 ha while the upland tall shrub community accounts for another 35 to 40 ha out of the total of 101.5 ha area of the Park (Figure 2). Previous surveys have identified aspen (*Populus tremuloides*) as the dominant tree species, with balsam poplar (*Populus balsamifera*) and white spruce (*Picea glauca*) having a small presence. The canopy of the tall upland shrub communities are dominated by saskatoon shrubs (*Amelanchier alnifolia*) with small and patchy intrusions of wolf willow (*Elacagnus commutata*) and choke cherry (*Prunus virginiana*). It appears that this shrubland has been maintained in a subclimax state for a very long time.

Project objectives

Overall

The two primary protection objectives for Saskatoon Island Provincial Park as stated in the Management Plan (1998) are:

1. The regeneration of the tall upland shrub communities by promoting healthy and productive saskatoon bushes and by encouraging ecological diversity in the park while providing an enjoyable and safe experience for visitors.
2. The management of the forested communities in the facility zone within the park so that they will remain healthy and viable for the long term and will be representative of the vegetation in the Peace River Parkland Subregion in Alberta.

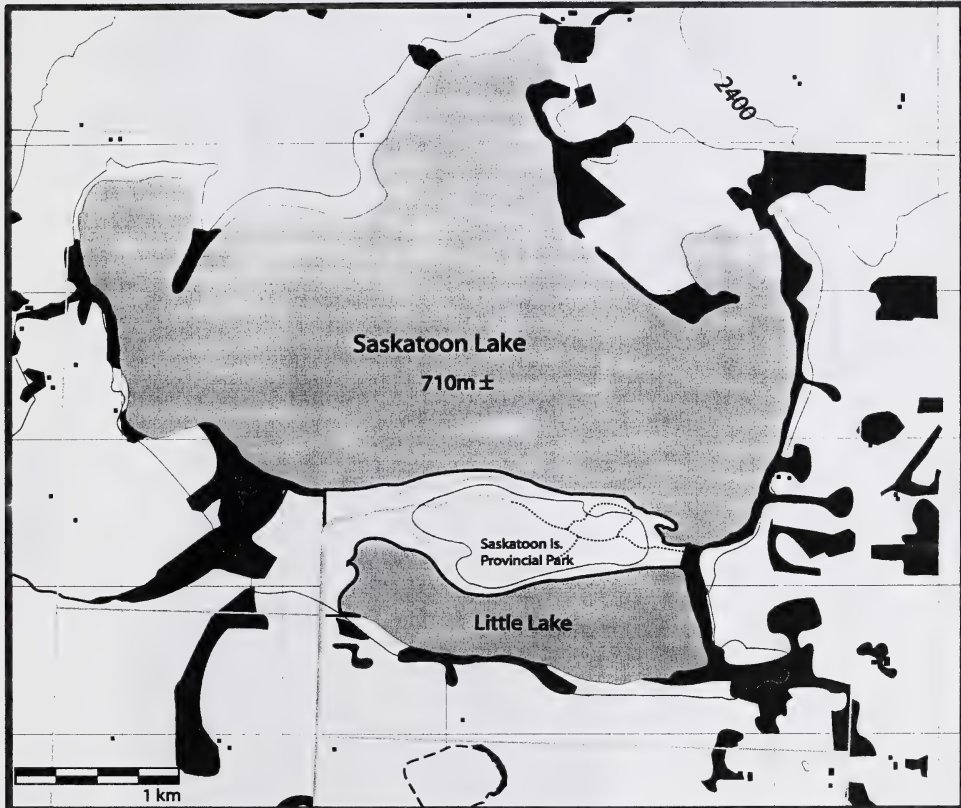


Figure 1. Map of Saskatoon Island Provincial Park and surrounding lands. Base mapping derived from NTS map 83M/3 (1985)

Specific Objectives

- Reclassification of the upland vegetation communities in the park by identifying the age of stands, height of stands and area covered, associations of dominant species, seral stages, and past and present disturbances such as disease, fire, pests and soil disturbances.
- Develop a profile of the tree species found in the different parts of the deciduous treed area.
- Develop a profile of the canopy species in the non-forested areas.
- Identify any meaningful correlations between the seral stages present and the conditions in each area.
- Identify areas which need to be rejuvenated.
- Recommend methods of rejuvenating the park vegetation.
- Suggest a way of creating a mixedwood forest in the Park, i.e. white spruce under an aspen overstorey.
- Develop an experimental design for the study of the ecology of wild saskatoon bushes and their associated tall upland shrub community so that appropriate and effective techniques can be employed in the management of these communities.
- Develop a monitoring scheme for long-term monitoring of vegetation changes.

Saskatoon Lake



legend

Plant Communities

- Coniferous (planted)
- Deciduous (sage)
- Lowland shrub
- Emergent/lacustrine
- Upland tall shrub
- Upland low shrub
- Clearing/meadow
- Agricultural
- Beach/shoreline
- Lawn

- Roads
- Pathways
- Plot locations
- Buildings

approx. scale 1:10 000

Figure 2. Map showing plant communities and the location of shrub and tree sampling plots

Methodology

Tree survey

Sixteen circular fixed-area plots were distributed so that each treed area was sampled for trees (Figure 3). The access route to each plot was ribboned to allow future access from the nearest trail or paved pathway. Each plot centre was marked by a wooden stake and identified by the plot number. Plot radius was 2.5 metres with a plot area of approximately 20 m². Within each plot all treed vegetation was recorded. Numbers of stems in the plot were recorded by species and categorized according to whether the stem was:

1. a tree - diameter at breast height (DBH) greater than 20 cm.
2. a pole - DBH from 10 to 20 cm.
3. a sapling - DBH less than 10 cm, also described as a sucker.

Other biological information that was gathered for each plot included the height and age of the tree nearest the plot centre, tree health of all the trees in the plot, the amount of coarse woody debris (CWD) per plot, and the number and species of stumps and snags (if recognizable) in each plot. Environmental data collected for each plot included crown coverage (as measured by the amount of vertical light entering the plot), soil temperature at approximately 5-10 cm depth at the plot centre, and the elevation in metres above sea level at the plot centre.

At each plot, a walk-through survey of the surrounding stand was conducted and comments were recorded on the general conditions of the stand, the presence of stumps and snags, tree health, conditions which were not present in the plot such as patches of aspen suckering, and the intensity of competing ground vegetation.

Ecological inventory

A total of fourteen 100-m² plots were established. These plots were marked semi-permanently with flagging tape and wooden stakes. Plot locations were mapped on air photographs and then incorporated into Figures 2 & 4. Eight plots were established in the upland shrub community and six plots in the forested area. Plots in the forested areas coincided with specific tree survey plots. Ecological Inventory Forms followed the Canadian Forest Products' Ecological Assessment and Cruising Manual (Manderson & Martens 1997).

Cover for all plant species was estimated as percent cover. Non-vascular plant cover was estimated as total cover per plot where feasible. The plants were grouped into **canopy** (>10m in height), **tall shrub** (1m-10m), **low shrub** (<1m) and **herb** (nonwoody plants) categories. Specimens of each species were collected, and prepared for deposit in the Grande Prairie Regional College herbarium. A second set of herbarium specimens are being prepared and will be deposited in the Saskatoon Island Provincial Park office. A species list was prepared (see Appendix I) and the species were checked against the tracking lists from the Alberta Natural Heritage Information Centre to determine if any of the plant species are rare or threatened. Species identified in this project were also compared with previous Saskatoon Island species lists (VanTighem and

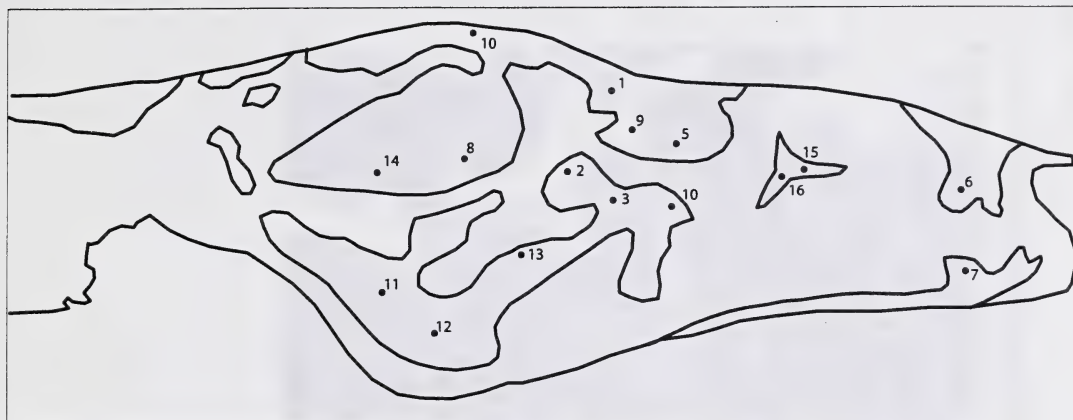


Figure 3. Location of the tree sampling plots

Wallis, 1973; Fairbairns *et al.* 1981; Zurfluh 1983; AEP 1998) and a set of herbarium specimens are being deposited at the Saskatoon Island Provincial Park office. Vascular plant nomenclature follows Moss (1983). Bryophyte nomenclature is after Anderson, Crum and Buck (1990). Lichen nomenclature follows Egan (1987). A list of nonvascular plants is given in Appendix II.

The largest stem of the dominant shrub (saskatoon, wolf willow or choke cherry) in each plot was collected and growth rings counted as a measure of the age of each stand in the tall shrubland plots.

The location of plots was determined with a GPS unit provided by Grande Prairie Regional College. Elevation for each plot was determined with a hand-held altimeter that was adjusted for atmospheric pressure twice a day. Estimated site characteristics included aspect, surface expression, slope degrees and position, moisture and nutrient regimes.

Soils were sampled by digging one 60-cm deep soil pit at each plot following the methodology used for field sampling in the Beckingham and Archibald (1996) manual for field sampling in order to determine the soil type and nutrient and moisture regime for each plot. The location of the soil pits were chosen carefully to minimise disturbance to the site and possible visual impact. Soil horizons and type were classified using the Canadian System of Soil Classification (Soil Classification Working Group, 1998). Soils were classified according to Beckingham and Archibald (1996) for ecosite classification. The field data were used to classify each site to the ecosite community level as described in the *Field Guide to the Ecosites of Northern Alberta* (Beckingham and Archibald 1996).

Additional observations and assessments were made on the diseases present on *Amelanchier* shrubs by our team and by a local commercial saskatoon grower who is also with the Department of Agriculture, Susan Meyer, who provided us with helpful information and advice. Unusual conditions or characteristics of the plots, evidence of browsed vegetation and an appraisal of the area surrounding each plot was also done.

The vegetation map (Figure 2) also shows roads and trails and the location of study plots and the tree survey plots locations. An aerial photograph (1987) was also reduced to report size and is included in the report.

Copies of detailed data sheets for the tree survey and the vegetation plots are attached in Appendix IV and Appendix V, respectively.



Figure 4. Aerial photograph (1987) of Saskatchewan Island Provincial Park showing the location of the tree and ecological inventory plots.

Results & observations

Tree survey

Forest zonation

The results of the tree sampling are summarized in Table 1. Note that in column one some of the plots contain two numbers. In these instances both the tree survey plot and the vegetation sample plot were at the same location. Table 2 contains pertinent tree survey data grouped into selected 'zones'.

Based on the information recorded at each plot and from observations made in walking through the treed areas, the wooded area in the Park can be divided into six separate zones, with Zone C divided into two sub-zones (Figure 5). While these 'zones' would probably not be classed as separate stands in operational forestry, the differences between them are important in this project.

Zone A (plot 10)

This zone forms a narrow strip on the north side of the park along the shore of Saskatoon Lake. Based on the plot information, there are about 500 aspen tree stems per hectare. The trees are between 85 and 90 years old. Although no balsam poplar trees were recorded in the sample plot, there are some mature balsam poplars in this zone. Snags are present throughout the zone, with suckers present in the openings around the snags. Ground vegetation is relatively moderate throughout.

Zone B (plots 1, 8, 9, 14)

Zone B surrounds the facility zone in the north-central part of the park and extends to the west of the open volleyball/baseball play area. Suckering is much in evidence here, with sucker numbers ranging from 4,000/ha (plot 8) to 9,000/ha (plot 14) (Plate I, A). Although mature aspen were only recorded in plot 8, there are older trees scattered throughout the zone. Stumps are also present throughout the zone. Three different age groups were noted, mature trees around 85 years, pole-size trees around 40–50 years and saplings (suckers) about 20–25 years. Ground vegetation is moderate to light throughout.

Zone C (plots 5, 6)

Zone C is subdivided into C1 and C2 groups because of the spatial separation between its two component parts. Vegetation-wise, however, it comprises a single zone. Mature aspen were 85–90 years old. Suckering inside this zone is sparse. There is some suckering at the zone edge near plot 6, at the eastern end of the park. The most noticeable feature of the zone is the abundant ground vegetation, with a variety of competitive herbs and shrubs throughout the zone (Plate I, B). Although there were no obvious health problems, a second tree had to be cored for age because the first was decayed in the centre.

There are about a dozen scattered white spruce along the lakeshore on the northern edge of Zone C1 and stretching eastwards for about 70–80 m into the non-treed area east of C1. Spacing between trees is irregular, anything from 5 to

Table 1. Tree survey results

Plot No.	Trees Age (year)	No. /ha	Poles Age (year)	No. /ha	Saplings Age (year)	No. /ha	Tree health	cover	Crown temp (%)	Soil Elev. (°C)	Stumps (m)	Snags /ha	Competition /ha
1(TD5)	-	0	60	4,000	19	6,500	none visible	70%	10	716	1,000	1,500	Moderate
2(T2)	-	0	55	1,000	18	2,000	none visible	40%	13.9	723	500	500	Moderate
3(T1)	70	1,500	-	0	16	3,000	core decayed	30%	13.3	723	0	0	Moderate
4	75	2,000	-	0	17	500	none visible	80%	13.9	723	0	0	intense
5	80	500	-	0	11	500	none visible	30%	14.4	726	0	0	intense
6	82	2,500	-	0	10	500	core decayed	70%	12.2	716	1,500	1,500	intense
7	75	2,000	-	0	-	0	conks on 2 trees	80%	8.9	714	0	0	intense
8(TD4)	80	500	33	500	16	4,000	none visible	70%	14.4	718	0	0	light
9	-	0	48	1,000	25	4,500	plot tree dead	30%	15	718	500	0	moderate
10(T3)	80	500	-	0	20	1,000	none visible	10%	15	713	0	500	moderate
11(TD6)	82	2,500	-	0	13	500	conk on 1 tree	80%	14.4	716	500	0	light
12	80	2,000	-	0	11	6,500	one dead tree	70%	13.3	716	500	500	light
13	82	500	-	0	13	3,000	none visible	35%	15.5	716	500	500	moderate
14	-	0	-	0	15	9,000	none visible	n/a	14.4	717	0	0	light
15	-	0	80	1,000	1-3	10,000	conks, <i>Venturia</i>	60%	17.7	720	0	0	moderate
16	75	1,000	-	0	1-3	20,000	conks on 2 trees	60%	19.4	720	500	0	Moderate

Table 2. Treed areas grouped into recognizable zones

Sampling area	Plot no.	Plot Age	Trees #/ha	Poles Age	Poles #/ha	Saplings Age	Saplings #/ha	health	Tree cover (%)	Crown temp (°C)	Soil Elev. (m)	Elev. stumps /ha	No. snags /ha	No. Competition
A	10	80	500	-	0	20	1000	none visible	10	15	713	0	500	moderate
B	1	-	0	60	4000	19	6500	none visible	70	10	716	1000	1500	moderate
B	8	80	500	33	500	16	4000	none visible	70	14.4	718	0	0	light
B	9	-	0	48	1000	25	4500	plot tree dead	30	15	718	500	0	moderate
B	14	-	0	-	0	15	9000	none visible	n/a	14.4	717	0	0	light
C1	5	80	500	-	0	11	500	none visible	30	14.4	726	0	0	intense
C2	6	82	2500	-	0	10	500	core decayed	70	12.2	716	1500	1500	intense
D	7	75	2000	-	0	-	0	conks on 2 trees	80	8.9	714	0	0	intense
E	2	-	0	55	1000	18	2000	none visible	40	13.9	723	500	500	moderate
E	3	70	1500	-	0	16	3000	core decayed	30	13.3	723	0	0	moderate
E	4	75	2000	-	0	17	500	none visible	80	13.9	723	0	0	intense
E	11	82	2500	-	0	13	500	conk on 1 tree	80	14.4	716	500	0	light
E	12	80	2000	-	0	11	6500	one dead tree	70	13.3	716	500	500	light
E	13	82	500	-	0	13	3000	none visible	35	15.5	716	500	500	moderate
F	15	-	0	80	1000	-	10000	conks, <i>Venturia</i>	60	17.7	720	0	0	moderate
F	16	75	1000	-	0	-	20000	conks on 2 trees	60	19.4	720	500	0	moderate

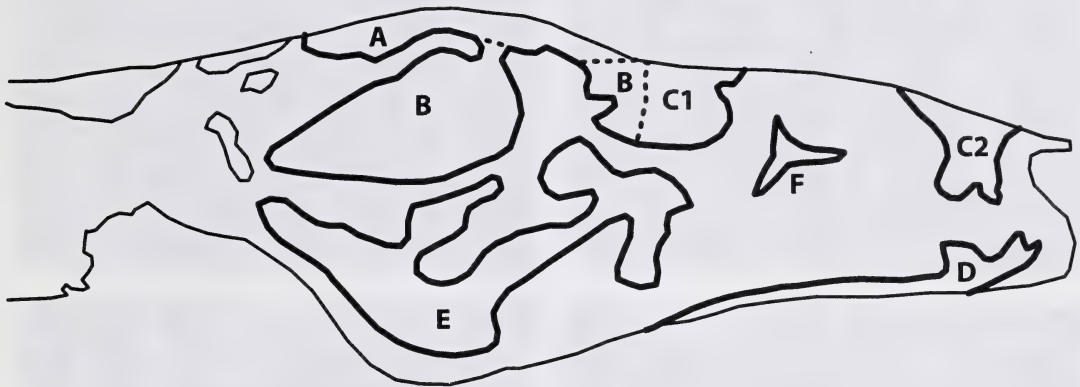


Figure 5. Tree zones in Saskatoon Island Provincial Park.

40 metres. Trees were aged at 55 to 60 years. A local long time resident of the Saskatoon Lake area, Mae Trelle, informed us that these spruce were undoubtedly planted by Fred George Webber who was named the first caretaker of the park in 1930 (Campbell 1975). Apparently Webber built a cabin and planted a large garden in the area where the spruce are located. Young white spruce regeneration is present around four of the trees where there is little vegetative competition and a suitable seedbed. The regeneration has not spread either into Zone C1 or into the saskatoon shrubland area east of C1.

Zone D (plot 7):

This zone is well stocked with mature aspen, approximately 80 years old. Canopy cover reduces the amount of light penetrating to the forest floor. Conks were noted on one of the plot trees and on a few trees through the stand. The 8.9° C soil temperature was lower than in any other plot. The sample plot has a thick duff layer of 25 cm. As in zone C the shrub and herb vegetation layers are very well developed (Plate I, C). Occasional patches of suckering were noted around snags and fallen trees. The open grassy area along the northern edge of the zone is being invaded by suckering from trees along the zone boundary (Plate I, D).

Zone E (plots 2, 3, 4, 11, 12, 13)

This is the largest treed zone in the park. Although the plot data appears to indicate otherwise, the zone is in fact quite similar throughout with suckers present in scattered open areas, indicating that gap replacement is occurring (Plate I, E). A wet, grassy, area just west of plot 4 shows some recent suckering (Plate I, F). Mature aspen range in age from 75 to 90 years. Ground vegetation is

light and non-competitive for the most part, but heavier in the vicinity of paths and trails. *Hypoxylon* was identified on two individual, widely separated trees, between plot 11 and plot 12. Conks were present on a tree in plot 11. Scattered stumps and snags are present throughout the zone. An interesting feature of Zone E is that many of the trees in the eastern edge of the zone are leaning in a south-southwesterly direction as if in response to wind. Aspen is a relatively windfirm species (Jones and DeByle, 1985), so the fact that trees are leaning is probably a testimony to their resistance to windblow. In fact the survey showed that very few trees, in this or any other zone, have been toppled by the wind.

Zone F (plots 15, 16)

Zone F is interesting in that it forms an apparently naturally discrete area of forest. It is surrounded on all sides by a dense growth of extremely tall saskatoon shrubs (4–5 metres). At 720 metres elevation it is the highest zone in the park. It also had the highest soil temperatures, averaging 18.5° C between the two plots. Tree ages are in the 80–90 year range. Conks were identified on one plot tree and on several trees through the stand. The zone is relatively open with a number of windblown trees, especially in the eastern half. While there is some vertical shading by the canopy, the zone is narrow and considerable light enters from all sides. Plots in this zone had the highest sucker count of all the sample plots. Aspen leaf and twig blight (*Venturia macularis*) was identified on some suckers. A number of 'deer beds' were identified here and browse damage is evident on many suckers. The damage indicates that this is probably an annual winter event.



Plate I: **A.** Abundant suckering in Zone B; **B.** Intense competition in Zone C; **C.** Intense competition in Zone D; **D.** Suckers invading grassy area along the edge of Zone D; **E.** Suckering around blowdown in Zone E; **F.** Suckering in grassy area in Zone E.

All Forest Zones

Mature aspen were found in all zones. Breast height ages ranged from 70 to 82 years. Assuming that it took five to seven years for the trees to reach breast height, the estimated ages of the oldest aspen trees in the park are from 75 and 90 years. Scattered individuals of a younger age class, approximately 40–50 years, were represented in zones B and E.

Suckering was observed in most zones but it was always patchy in nature (Plate II). The highest level of suckering occurred in zone B, and was considered adequate for restocking throughout the zone. The key observation here is that wherever suckering occurred, it was almost always associated with felled or windblown trees.

Also of interest in Zone B is the fact that the sapling numbers from the different plots provide an excellent illustration of the self-thinning capacity of aspen (Figure 6). This phenomenon can be observed in natural stands in the years immediately following a stand disturbance such as fire or harvesting.



Plate II. Suckering in aspen

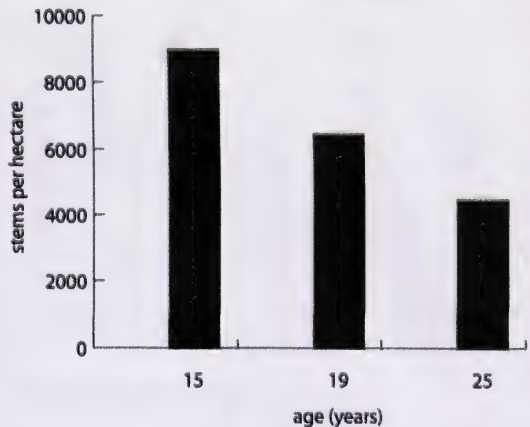


Figure 6. Changing aspen density over time

Insects and Diseases

There was no evidence of insect problems last summer, although the forest tent caterpillar (*Malacosoma disstria*) has been observed in large numbers in past years when peak populations of the caterpillar have occurred.

Lichens often inhabit the bark of old aspens (Plate III) and are sometimes thought to be parasitic on the trees. In reality, although the lichens can be used as indicators of tree age and air pollution, they do not parasitize the trees but are simply 'piggybacking' a ride on the tree trunks to raise them higher off the ground where more light and air are available. The result is that they provide interesting microhabitats for small invertebrates and a colourful display for park visitors.

Although stem decay (evidenced by the presence of stem conks) (Plate IV, A) was the most plentiful disease observed, it was not in fact present at significantly high frequencies. However, there are a number of fungi which cause stem decay. Their presence is largely a function of age. Although stem decay is not even close to epidemic levels, there are many of the stems in the Park in the 85–90 year age class. It is expected that aspen decay will increase and become a more prominent feature in the park in the near future. Hypoxylon canker, (*Hypoxylon mammatum*) (Plate IV, B), a serious disease of aspen, was only observed on a couple of individual trees in Zone E. Leaf and twig blight of aspen (*Venturia macularis*) (Plate IV, C) is a fungus which attacks young regenerating aspen. It was identified on a few suckers in Zones E and F. It affects height growth to a limited extent, but does not cause mortality. *Armillaria* spp. which can cause root rot were not encountered any-



Plate III. Lichens growing on the bark of an old aspen tree

where in the Park, either in survey plots or on walk-throughs.

Browsing

Many of the suckers in Zone F showed evidence of browsing (Plate IV, D) on a regular basis and the presence of 'deer' beds indicated heavy ungulate use in this zone. A recent survey indicates that moose have caused considerable damage to the aspen saplings this past winter, particularly along trails, around the edges of the forested areas and in the saskatoon shrublands in general.

Soil Temperatures

In four of the six Zones, soil temperature at the time of the survey was around 13–15° C. This falls pretty well within the required minimum temperatures for suckering to be possible. In Zone F the temperature was

substantially higher at 18.5° C. This approaches the optimum of 20° C for suckering.

In Zone D however, soil temperature was much lower at 8.9° C. Most probable reasons for the lower temperature in this Zone are the nearly unbroken aspen canopy, the mass of ground vegetation and thick horizon of organic soil. Furthermore, soil temperatures in Zone D are clearly low enough to inhibit suckering, but it is difficult to isolate soil temperature as a stand-alone factor inhibiting suckering. Soil temperature in the grassy area north of Zone D where suckering is actively occurring is 2–3° C higher.

Vegetative Competition

The level of shrub and herb competition in Zones C and D is sufficient to inhibit the survival of aspen suckers. In Zones A, B, E and F, vegetative competition is mostly light to moderate and not likely to stifle any aspen suckering.

Most of the treed zones in the park are bordered by a wide band of dense vegetation, consisting primarily of old, tall, almost impenetrable saskatoon shrubs. Saskatoons reproduce by suckering and with the dense root systems in the old, established tall shrubland areas the possibility of aspen invading these areas immediately surrounding the treed zones is very unlikely.

Light Reaching The Forest Floor

As mentioned earlier in the report, the reduction or absence of light reaching the forest floor does not affect production of suckers but can affect their survival. Most of the treed zones have a high degree of crown cover (Plate V, A). However, many parts of these Zones, especially in Zone F, are narrow so that the interior parts of the zone receive considerable diagonal light from the zone edge (Plate V, B). Two areas where light could be a potentially limiting factor to sucker survival are in Zone D and the western part of Zone E.

Not only does forest shade provide cover for park animals and shade-tolerant plants, but park visitors can find inviting woodland trails for a stroll on a hot summer afternoon (Plate VI).

Ecological Inventory

Plant species lists

A total of 172 vascular plants were identified in the park during the 1998 field season that began on June 1st

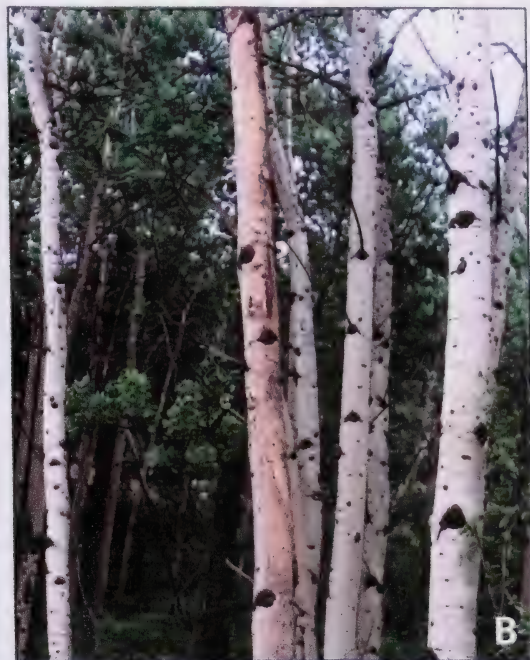


Plate IV. A. Stem conks on aspen; B. *Hypoxylon* canker on aspen; C. Aspen leaf and twig blight; D. Browse damage on an aspen sucker.



Plate V. **A.** Crown cover at plot 4 (Zone E); **B.** Zone F receiving light from the side.



Plate VI. An inviting forest trail

1998. Spring came early in 1998 and many of the spring plants had finished blooming by the first week in June when the field work began. Thus, our plant collection is incomplete at this time. We anticipate an expanded plant list based on this spring's collection which will begin on May 16th. A complete list of vascular plants as of December 31, 1998, is presented in Appendix I.

Although there were a number of invasive, non-native plant species identified in the park, we found no rare or endangered vascular plants from the Alberta Natural Heritage Information Centre's *Vascular plant tracking list* (1999). However, some less common plants were found, such as the striped coralroot (*Corallorhiza striata*) (see Plate VII, A) and the beautiful western wood lily (*Lilium philadelphicum*) (Plate VII, B).

Seventy-three non-vascular plant species (mosses and lichens) were also identified from the vegetation sample plots; these are listed in Appendix II.

Plot sampling results

A total of 14 plots were sampled for ecological characteristics, six in the treed zones and eight in the tall upland shrub areas of the park. Plot locations are mapped in Figure 2.

The ecological survey and general observations indicated that there were some obvious patterns that could be expressed as zones for the forested areas but that zoning the upland shrub communities would be impractical if not impossible. With the exception of a few small meadow-like areas and some other shrubby areas dominated by wolf willow (*Elaeagnus commutata*) or chokecherry (*Prunus virginiana*), the upland shrub community consists of a vast expanse dominated by saskatoons in various successional stages. These successional patterns are expressed as small differences in understorey species composition, and in the age classes, sizes and densities of the dominant shrubs. Most of these differences occur in relatively small patches that can be as small as a few metres square or up to a hectare or more in size.

Vegetation

Table 3 provides a summary of the vegetation plot characteristics. In both Tables 3 and 4 snowberry and buckbrush have been combined into a single category (*Symphoricarpos* spp.). We estimated that there were close to equal numbers of each species in the park and because of the very close similarity between the two species, especially when there are no flowers or fruit present, and no clear differences in habitat preferences we could not justify an accurate separation of the two species without further analysis. For each plot the dominant vascular plant species at the canopy, shrub and herb layers is identified. The number of species (a measure of species diversity), the age of the dominant canopy species, estimated height of the canopy, and the elevation of the site (numbers in parentheses indicate a difference in altimeter readings between vegetation sampling and tree survey measurements) are also shown. The soil column has been simplified to show only the general soil type.

In terms of the presence of the more common vascular plants, the most abundant tall shrub in the park was the saskatoon (*Amelanchier alnifolia*). It was found in every sample plot and, based on plot data, it represents an average of close to 47% cover over the forested and upland shrub communities in the park. Forty-seven percent is probably a low estimate since all of the drier

sites contain at least some saskatoons. Based on walk-through observations, we would estimate approximately 65–70 % saskatoon cover in the park. By far the most abundant low shrub occurring in the park was the prickly rose (*Rosa acicularis*) (Plate VII. C). This plant occurred in all but two of the plots sampled and accounted for an overall average cover of 23.5 % percent. Grasses although seldom counted in large numbers were present in almost all of the plots to some degree and overall they accounted for about 18 % of the herb cover in both the tree and shrub communities. Percent cover data for the most common plants is presented in Appendix III.

A comparison of the forest and upland shrub plant associations is presented in Table 4. Most of the common species occur in all parts of Saskatoon Island Provincial Park. Although the forest communities contain substantial numbers of saskatoons, not one of our upland shrub community plots had a single aspen present, even a sapling (or sucker) of an aspen. Red osier dogwood, bracted honeysuckle and dewberry were also absent from the shrubland plots but in smaller numbers. On the other hand all the common plants in the park were present in at least one forest plot except for Lindley's aster.

Based on the average percent covers of the vascular plants in Table 4. A typical mature forest community in the park would include several of the following species from the most to the least common: aspen, saskatoons, red osier dogwood, prickly rose, marsh reed grass, snowberry/buckbrush, showy aster, and bracted honeysuckle. The mature upland tall shrub community would consist of some combination of: saskatoons, snowberry/buckbrush, prickly rose, northern bed straw, cow parsnip, and Kentucky bluegrass. Wolf willow and chokecherry might also be present in small numbers or patches in the upland shrub community. Other less common species would be present in varying amounts in both forest and shrub communities and would account for the differences in species diversity occurring in the different plot samples. The presence and cover values of these understorey plants is primarily dependent upon micro-environmental variables such as light penetration, moisture regime and seral stage.



Plate VII. A. Striped coral-root; B. Western wood lily; C. Prickly rose

Table 3. Summary of vegetation plot characteristics

Plot No.	Dominant Species*			No. of Spp.	Age of Dom.Sp.	Canopy Height	Elevation (m)	Soil type & Moisture Regime†
	Canopy	Shrub	Herb					
S1	amelaln	rosaaci	heraanl	24	40	<1	722	Chernozem-m
S2	amelaln	rosaaci	galibor	14	25	≥1	735	Chernozem-d
S3	amelaln	sympspp	galibor	24	30	>1	725	Chernozem-m
S4	amelaln	sympspp	poapalu	28	7	≤1	730	Chernozem-d
SD5	elaecom	sympspp	schipur	16	30	≥2	719	Chernozem-d
SD6	amelaln	sympspp	galibor	–	50	≥4	725	–
SD7	prunvir	sympspp	heralan	14	30	>1	721	Luvisol-d
SD8	amelaln	sympspp	heralan	11	45	3	731	–
T1 (3)	poputre	amelaln	calacan	21	70	14	730 (723)	Chernozem-m
T2 (2)	poputre	cornsto	vacccae	24	55	17.5	740 (723)	Luvisol-d
T3 (10)	poputre	amelaln	calacan	22	80	–	715 (713)	Luvisol-d
TD4	poputre	sympspp	astecon	21	–	–	720 (718)	Luvisol-m
TD5 (1)	poputre	amelaln	astecon	21	60	15	735 (716)	Luvisol-m
TD6(11)	poputre	cornsto	mertpan	23	82	19.25	715 (716)	Luvisol-m

Numbers in parentheses are tree survey plot numbers and elevations; *Species code names=first four letters of genus plus first three letters of species (ex. amelaln= *Amelanchier alnifolia*); †m=moist, d=dry

Soils

Detailed information on the soil in each plot can be found in Appendix V. For our purposes, soil types were designated as moist (m) or dry (d) Chernozems or Luvisols (Table 3). Although some of the soil pits showed signs of gleying and some were at least slightly solodized, they essentially fell into one of the two above categories, Chernozem or Luvisol. The moisture levels were difficult to assess because of the very dry summer season in 1998 and as a result we found only slight differences among the plots. In most cases, the tall upland shrub communities contained Chernozem-like soils (characteristic of prairies) (Plate VIII, A) while the communities dominated by aspen contained mostly Luvisolic soils (Plate VIII, B) which are characteristic of many boreal forest soils.

Treed Communities

Populus tremuloides (aspen) was the dominant tree in all the plots sampled. Saskatoon shrub was the most common understorey tall shrub while red-osier dogwood (*Cornus stolonifera*) tended to occur in the moister plots while snowberry/buckbrush (*Symphoricarpos* spp.) was found on the drier sites. The grass *Calamagrostis canadensis*, *Aster conspicuus* and *Mertensia paniculata* were the most common understorey herbs. There was an

overall similarity of understorey vegetation in all six of the treed plots.

Species diversity based on the number of vascular plant species present in the treed plots showed very little variation with a range of 21 to 24 spp. and a mean of 22.

Table 4. Forest and upland shrub plant associations

Plant common name	Average percent cover	
	forested areas	upland shrublands
Aspen	60.0	0.0
Saskatoonberry	33.2	57.1
Snowberry/buckbrush	14.3	48.5
Red osier dogwood	31.7	0.0
Prickly rose	22.0	24.5
Northern bedstraw	3.7	23.9
Cow parsnip	1.3	19.0
Grass spp.	18.3	18.1
Showy aster	10.0	0.6
Bracted honeysuckle	5.7	0.0
Veiny meadow rue	4.1	1.2
Dewberry	4.0	0.0
Fireweed	2.8	3.5
Lindley's aster	0.0	2.4
Northern gooseberry	2.0	2.1
Wild red raspberry	1.7	1.9
Twining honeysuckle	0.3	1.0



Plate VIII. A. Chernozemic soil; **B.** Luvisolic soil

Based on two sets of measurements, the elevation of the treed plots ranged from 713 m to 740 m. Differences in elevation recorded between the two sample plot measurements is probably related to changes in barometric pressure at different times of day and on different dates. Even so, these measurements show very small variations at a macrotopographic level. In terms of microtopography however, small differences can account for differences in vegetation cover. For instance, slightly lower areas with poor drainage may support entirely different plant communities from dry well drained sites. Crown cover and the presence of grass appeared to be correlated. The two plots that had a relatively high percentage of *Calamagrostis* also had relatively low crown cover, T1 at 30% and T3 at 10% crown cover (see Tables 2 & 3).

Canopy height for the trees was not measured in the ecological inventory, but data from the tree survey is included in Table 3. The range of heights were from 14 m to over 19 m. Canopy height did not appear to be correlated with forest stand age in this study.

Upland Shrub Communities

Six of the eight tall upland shrub sample plots were located in saskatoon-dominated areas. Of the remaining two plots one was dominated by chokecherry (*Prunus virginiana*) (Plate IX, A) and the other was a wolf willow-dominated plot (*Elaeagnus commutata*) (Plate IX, B). These are the three basic types of tall upland shrub communities occurring in the park. By far the most common type (about 90% of the tall upland shrub communities) is the saskatoon-dominated community. The primary understorey, low shrub species in the uplands were snowberry/buckbrush with the prickly rose in second place. Cow parsnip (*Heracleum lanatum*), northern bedstraw (*Galium boreale*) and Kentucky bluegrass (*Poa pratensis*) were important understorey herbs in the upland shrub community. The dominant canopy species appeared to have no significant effect on the primary understorey composition of the upland shrub community.

Species diversity as measured by the number of species present per upland shrub plot ranged from 11 to

28 indicating a much broader range of species diversity in these communities than the forested stands. Our study shows that although the range of the number of species is greater, the average number of species per plot is only 18.7 as compared to the average of 22 in the forest plots. The highest species number occurred in the youngest (7-year-old) saskatoon stand, where there was abundant light and soil that appeared to have been disturbed in recent years. Earthworms were present at 15 cm indicating well aerated and moist soil.

Canopy Height

Canopy height was estimated for the upland shrub communities. In most cases the age of the saskatoon stands was a reliable indicator of the height of the saskatoon stems. For instance the saskatoons in the 50-year-old stand (SD6) were 4 m or more in height, while the 7-year-old stand had saskatoon stems that were less than 1 metre in height. A regression analysis was performed and the results indicated a correlation coefficient

of 0.80 for the age of saskatoons shrubs versus their height (Figure 7).

Ecological Succession

Our data and observations indicate that early successional stages (0–20 years) of the upland shrub community are dominated by young saskatoons less than 1 metre in height, and the low shrubs, prickly rose and snowberry/buckbrush. There is usually fairly high species diversity, especially among the grasses and herbs. The most abundant herb species include Kentucky bluegrass (*Poa palustris*) and the herbs Canada golden rod (*Solidago canadensis*), northern bedstraw, and two *Aster* species.

Mid-successional stages (25–35 yrs) tend to have taller (1–2.5 m) saskatoons, larger rose and snowberry/buckbrush shrubs and twining honeysuckle (*Lonicera dioica*), fewer grasses, and a lower species diversity among the herbs as shade from the shrubs becomes a limiting factor. In some well-drained and/or disturbed areas northern gooseberry (*Ribes oxycanthoides*) and wild red



Plate IX. A. Plot dominated by chokecherry; B. Plot dominated by wolfwillow

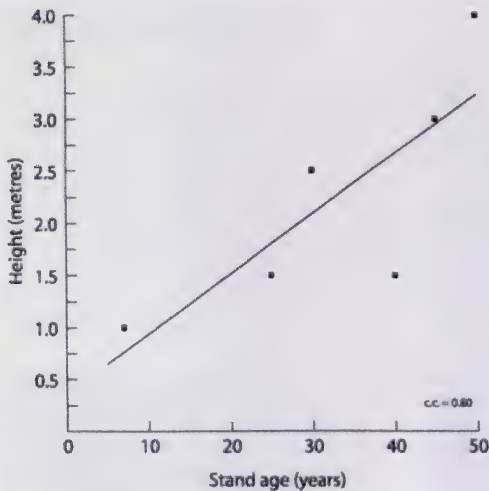


Figure 7. A positive correlation between saskatoon stand age and height

raspberry (*Rubus idaeus*) are common spreading, low shrubs on the early to mid-successional stage sites. Some of the more common herbs present include fireweed (*Epilobium angustifolium*), northern bedstraw (*Galium boreale*) and veiny meadow rue (*Thalictrum venulosum*).

Mature saskatoon communities (40+ yrs) usually develop dense thickets that are nearly impenetrable (Plate X, A) and often too tall (2–4+ metres) for berry pickers to reach the tops where the berries are. Many of these older stands can be found along the trails in the northeastern part of the park (Plate X, B) and, as mentioned earlier, the oldest of the saskatoon thickets tend to occur in strips adjacent to the old aspen forests throughout the park. The most common understorey shade-tolerant plants are the low shrub snowberry and the herbs cow parsnip (*Heracleum lanatum*) and northern bedstraw (*Galium boreale*).

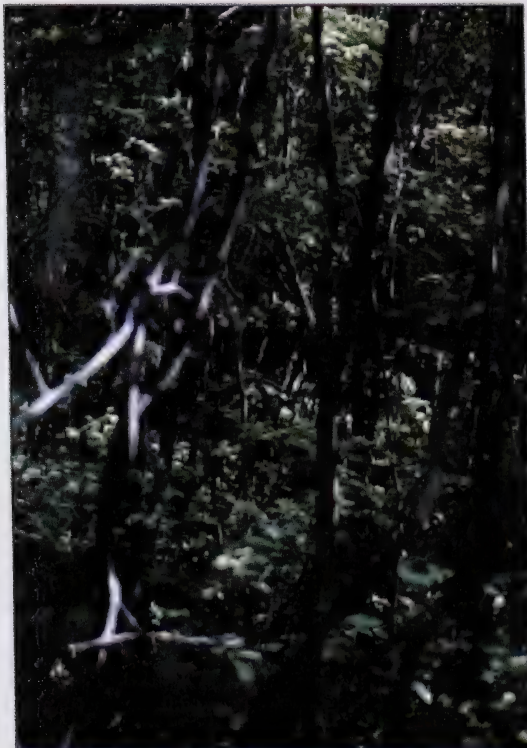


Plate XI. A. Dense thicket of 50-year old saskatoons (SD6); B. 45-year old saskatoon stand alongside a trail.

Insects and Disease

Although there are many insects and diseases that can damage saskatoons, our observations indicated that at the present time there are only two potential disease problems in the park at this time, the fungi, black leaf (*Apiosporina collinsii*) (Plate X), and leaf spot (*Entomosporium mespili*), both of which were identified at various locations throughout the park. Our observations were confirmed by Susan Meyer, a commercial saskatoon grower in the area; who did a walk through the park in late summer.



Plate X. Black-leaf on a saskatoon shrub.

Leaf spot was found in a few places in very small amounts. Black leaf, however, is very common on the saskatoons, especially in the wooded areas and in the old, dense saskatoon stands where light levels are low. We also observed fairly substantial amounts of black leaf this spring in a small patch (about one-third of a hectare) of young saskatoon bushes that was burned about 15 years ago in the northeast section of the park as an experiment to reduce the occurrence of black leaf. Apparently, three years after the burn, black leaf was almost nonex-

istent. However, 10 years later, not only has it returned in substantial amounts, but there has been an intrusion of grasses and woody species that are characteristic of disturbed areas and mid-successional stages such as raspberries and gooseberries. A second experiment done in that area at the same time involved pruning the black leaf off the ends of all the saskatoon branches in a patch about the same size as the burn, removing the cuttings from the patch and then burning them. This procedure amounted to a kind of simulated ungulate browsing. Today, some 12–15 years later, the saskatoon plants are healthy, the patch shows minimal intrusion of earlier seral stage plants and there is very little black leaf present.

Browsing

The effects of browsing were evident throughout the park. Moose, deer and snowshoe hare are the primary browsers and in both the wooded and upland shrub areas, young aspen, willow, saskatoons and red osier dogwood were all heavily browsed. This past winter was especially difficult for moose because of a major tick infestation and poor food quality. The result was that they congregated in the park where they broke off the aspen saplings and then fed on the tips of the branches. They browsed off the tips of those saskatoons they could reach and broke off the tops of some of the taller bushes. The hares stripped the bark from young aspen trees, saskatoon stems and the branches that had been felled by the moose. Deer are also present in the park, but the effects of their browsing were difficult to distinguish from the moose activity. Although browsing in the park appeared to be excessive and damaging to the vegetation this past winter, our observations from last summer indicated that relatively heavy browsing occurs every year as evidenced by old clipped branch tips and multiple branching at the tips of saskatoon twigs that occurs in plants adapted to browsing animals.

Discussion

Forested communities

As aspen age they become more susceptible to drought and disease. Recent studies on the decline of aspen in the Grande Prairie area indicate that insect defoliation, drought, spring freeze-thaw events and damage by fungi and wood-boring insects are the main causes of the reduced growth and dieback (Hogg, 1999). The reproductive strategies of aspen are important for the overall recovery and sustainability of these parkland forests.

Reproductive Biology of Aspen

Central to this project is reproduction and the factors involved in reproduction of aspen. In this section of the report we review the variables which control reproduction. In the sections following, survey results are summarized and discussed in relation to these reproductive variables.

Sexual reproduction

Research in recent years has shown that, contrary to long-held belief, aspen can effectively reproduce by seed. An abundance of seedlings has been observed in what were formerly the Edson, Whitecourt, Rocky/Clearwater and Grande Prairie Forests (Peterson and Peterson, 1992). Seedling numbers ranged from 1,000 to 16,000 per hectare. Aspen can typically flower as early as 10–15 years with individual trees producing more than one million seeds annually. Seeds lack endosperm and are short-lived, but can germinate over a wide range of temperatures. The primary requirement for successful germination is a moist seedbed (Steneker, 1976), usually best provided by a mineral soil.

Asexual reproduction

Sprouting—Harvesting of young stems can result in sprouting from the stump and root collar. The key factor here is the age of the harvested stems.

Suckering—By far the most important method of reproduction in aspen is the production of root suckers. A root sucker is a vertical shoot which originates from a root (Plate II). Typically suckering occurs on roots between 5 and 15 cm depth (Horton and Maini, 1964). Initially, the sucker derives its nourishment from the parent root. Once above ground level it produces green leaves and functions as an independent plant. Root suckering is most noticeable after a stand disturbance, usually fire or harvest. The important variables in suckering can be separated into, (a) variables affecting production of suckers, and (b) variables affecting survival of suckers.

The variables affecting suckering can be easily identified. However, they are interrelated and interdependent to a degree that makes it difficult to isolate the effects of any one variable. A literature search confirms the following as the most

important factors controlling and affecting suckering. It appears that the absence of suckering in much of the treed area of the Park is not due to tree health problems.

Shoot/root hormonal balance—This phenomenon is also described as apical dominance (Navratil, 1991). Auxins are hormones produced in the above-ground parts of the plant. They suppress root suckering. Cytokinins are hormones formed in the root which promote suckering. When the flow of auxins from the shoot is interrupted by a disturbance, sucker development is initiated. Examples of such a disturbance would include harvesting and fire.

Soil temperature—The literature contains somewhat conflicting reports of the relative importance of apical dominance and soil temperature. Navratil, 1991, suggests apical dominance as the primary factor. However, soil temperature is cited as the critical requirement by Maini and Horton (1964). To some extent this is a 'chicken-and-egg' situation as a disturbance such as harvesting or fire, which removes apical dominance, will also result in increased soil temperature. However, observation along the edge of undisturbed, isolated, aspen stands in grassland areas will often reveal the invasion of grassland by suckering from the aspen stand. In this case soil temperature would appear to be the dominant factor. Maximum sucker production has been reported at 20° C (Steneker, 1976), while Maini (1967) reported that suckering was inhibited at temperatures below 15° C.

Soil moisture levels—In a generic discussion of factors necessary for suckering, moisture levels would undoubtedly be listed (Maini and Horton, 1966). However, in the present situation soil moisture levels are not a controllable factor, only in as much as they might be slightly altered by manipulation of the aspen stand.

Soil physical properties—In operational forestry there has been increasing concern in recent years over the effects of the physical properties of soil on suckering potential. The property of most concern is soil compaction. Although the relationship between soil compaction and suckering has not yet been established it is generally accepted that increasing soil compaction has a negative effect on suckering (Standish *et al.*, 1988).

Stand age—Thinking on the importance of stand age has evolved over the years. The current view is that increasing stand age is not a deterrent to suckering. As long as a tree has a live crown it can produce root suckers following disturbance (Perala, 1991). A stand basal area of 5 m²/ha is sufficient to regenerate a stand so long as trees are well distributed (Doucet, 1989).

Root condition—Root condition refers to the health of the root, rather than the age. Successful sucker production requires a sound, disease-free, root system. In this regard, the most likely problem would be Armillaria root rot (shoestring fungus) (*Armillaria* spp) (Hiratsuka *et al.*, 1995). Even though root rot was not found in the park, aspen is particularly susceptible to Armillaria, which is widespread through the province and there is concern that the old forest stands in the park may succumb to this disease, especially if moisture conditions become amenable for its growth over a few summer seasons.

Genetic disposition—Interclonal differences in suckering in response to temperature have been reported from Alaska (Zasada and Schier, 1973). Few studies have been reported on genetic control of suckering. The question most often asked is whether some clones are genetically more disposed to suckering, or whether they are simply more resistant to diseases such as root rot, which could reduce suckering potential.

Survival of suckers—The first essential in regeneration of aspen is production of suckers. However, of equal importance is their subsequent survival. Factors affecting survival are interrelated with each other and also strongly interrelated with the factors affecting production of suckers. Major variables involved in survival are:

- **Light**—Aspen is a light-demanding (shade-intolerant) species and early suckering does not survive under a residual canopy or when deprived of light by other vegetation (Navratil, 1991).
- **Soil temperature**—Soil temperature was listed as being necessary for production of suckers. However, as with all plant life, optimum soil temperatures are also necessary for continued growth and survival of the young regenerating plant.
- **Competition**—Given that suckers receive their early sustenance from the parent roots, the major effects of vegetative competition are likely to be (a) deprivation of light (b) reduction of soil temperatures and (c) sometimes, the sheer physical press of competing vegetation.

Recreating the history of the forested areas

The history of the forested areas of the Park can be satisfactorily pieced together from the survey results. The mature aspen which are scattered through the Park range from 75 to 90 years in age. This would indicate they had a common origin, almost certainly from some type of natural disturbance. The most likely disturbance would have been a large scale fire in the late 1800's or the early part of the 19th century.

Since then suckering has been suppressed, or occurred only in patches, in Zones A, C, D, E and F. Reasons for the lack of suckering are simply that, for the most part, the biological requirements for suckering were not present:

- (a) Apical dominance was maintained.
- (b) Soil temperature, light reaching the forest floor and vegetative competition were less than optimal, although these conditions were not uniform across all Zones.

Zone B is the only Zone with consistent, satisfactory, stocking of aspen across the Zone. Sapling ages range from 15 to 25 years. The satisfactory stocking can be traced to the presence of stumps from trees felled throughout the Zone. Presumably these trees were felled during development of the Facility Zone in the Park. Although there are still scattered older trees throughout, enough were removed to create the necessary conditions for aspen suckering, and for survival and development of the suckers. Removal of these trees replicated the type of disturbance caused by fire in natural forests and by clear-cutting in managed forests. Growth patterns of the saplings in Zone B also fit those of natural stands, with stems per hectare decreasing with age due to natural self-thinning.

The presence of a few scattered white spruce planted on the northern shore in the early 1900's appear to have been successful in reproducing since regeneration is present along the shore where there is a lack of competition and more importantly, a suitable seedbed.

The report on management strategies for aspen forests in provincial parks in Alberta by Higginbotham (1980) which can be found in the Saskatoon Island Provincial Park library, should provide you with an excellent review of issues surrounding park management of aspen.

Upland Shrub Communities

A large volume of information is available to anyone who is interested in growing saskatoons commercially. Probably the best publication for those who would

pursue such an endeavour in Canada is the *Commercial Saskatoon Berry Production on the Prairies: A Grower's Guide* by Sara Williams (1991). Having said that, the reality is that very little is known about the biology and ecology of wild saskatoons and their associated ecosystems. A literature review, however, provided a few clues that can be applied to the upland shrub communities in Saskatoon Island Provincial Park.

Saskatoons thrive in well-drained, coarse and slightly acidic soils that are rich in phosphate (Beresford-Kroeger 1998). In western Canada where *A. alnifolia* is the only *Amelanchier* species occurring in the wild, it extends from the prairies, though the lower foothills and montane zones into subalpine habitats (Russell 1979). Most accounts of the occurrence of western saskatoon indicate that they are a hardy and ubiquitous shrub that can occur in dry to moist, well-drained coniferous and deciduous forests, open hillsides, shrubby thickets and roadsides, woodland borders and open woodlands (Moss 1983; Scoggan 1978; MacKinnon et al 1992; Johnson, et al 1995).

Perhaps one of the most interesting descriptions of saskatoon ecology comes from a 1938 publication by Shoemaker at the University of Alberta College of Agriculture who states:

A. alnifolia...under natural conditions and varying habitats ranges from a small shrub 3 feet high to a tree-like shrub 20 feet high. One of the few wild fruits that ranges from the north to the south of Alberta...The most promising type of Saskatoon so far collected is from Saskatoon Island in the Peace River District. In the Peace, the Saskatoon is widely distributed, especially in the more open areas on less frosty lands.

Saskatoons have been noted for their longevity where individual stems can live up to 70 years, while root crowns probably survive much longer (Hardy BBT Ltd. 1989). In our study the oldest stems found were 50 years, which suggests that without some management, these older stands will show serious declines over the next 20 years probably through an increase in disease susceptibility and perhaps a loss of palatability for browsing animals.

Studies on using woody shrubs on reclamation sites in Alberta indicate that Saskatoons have a high drought tolerance even among seedlings (Hardy BBT Ltd. 1989). This drought hardiness would account for their longevity in the dry, well-drained sites on 'Saskatoon Island'. However, due to this moderate tolerance to shade, increased humidity in shaded areas either from aspen or crowding from multiple stems in older stands, fungal diseases may become prevalent (as is indicated by the



increased incidence of black leaf in forested areas and older saskatoon thickets in the park).

It is estimated that in general natural propagation by seed in saskatoons accounts for about 20% of their total reproduction with birds as the primary dispersal agent. In order for seed to become established, disturbances which remove the humus layer such as fire or mechanical disturbance are required. One study (from Hardy BBT Ltd. 1989) showed increased plant density from the regeneration of suckers as a result of spring burning in east central Alberta although it took considerable time to reach pre-fire condition.

The remaining and most prolific propagation results from the production of stolons (underground stems) that form suckers in the form of colonies of upright stems. According to Hardy BBT Ltd. (1989) a single clone can form thickets up to 0.4 ha in size. On 'Saskatoon Island' we would suggest that although some of the clones may be larger than 0.4 ha, the extremely patchy vegetational environment may be partially accounted for by the distribution of small clones of saskatoons.

Another factor which is important to the growth of saskatoons is the presence of vesicular-arbuscular mycorrhizal association with the roots. The other two canopy-forming tall shrubs on Saskatoon Island (chokecherry and wolf willow) have similar mycorrhizal associations which are known to greatly enhance the uptake of nutrients in the plants. Without mycorrhizae, growth can be greatly reduced, especially where soil nutrients are limited. Any replacement following fire or other disturbance would require the early establishment of mycorrhizae to insure rapid regrowth of the plants.

No discussion of any ecosystem would be complete without examining the problems of disease and insect infestations. Although no serious insect infestations of saskatoons have been detected in the park there are some insects that could cause serious damage if they should appear. Apple curculio, leafrollers, McDaniels spider mite, saskatoon bud moth, saskatoon tarnished plant bug, tent caterpillar and other defoliators, and the woolly elm aphid are all potential insect pests (Davidson 1986, Williams 1991). It is hoped that the saskatoon stands can be maintained in a healthy state without most of these pests, because biological controls would be the only feasible option for their control. Pesticides in the park would not be acceptable in any case.

The potential fungal and bacterial diseases of saskatoons include black leaf (witches' broom), *Botrytis* grey mold, *Cytospora* dieback and canker disease, damping off of seedlings, *Entomosporium* leaf spot, fire blight, mummy berry/brown rot, powdery mildew, saskatoon-juniper rust, and silverleaf (Davidson 1985, Williams 1991). The fact that only two of these diseases (black leaf and leaf spot) have been detected in the park suggests

that although commercial saskatoon bushes are subject to these diseases, wild saskatoons may have evolved community and species specific adaptive mechanisms which limit the presence many of these diseases.

The question of why saskatoons have maintained a dominant role on Saskatoon Island for such a long time must be addressed and ultimately leads to a question of competition. What are the advantages and disadvantages of being a saskatoon shrub on this small 'island'?

First of all, with respect to the competing tall shrubs, although wolf willow is winter hardy, and can fix its own nitrogen through a symbiotic association with a nitrogen-fixing bacterium, *Frankia* sp. (Visser, 1998), it has a low palatability for browsers, and it has a low tolerance for drought. This drought-intolerance would automatically restrict its growth to locations (microhabitats) where moisture is present most of the time and it would have a strong competitive advantage in these locations due to its nitrogen-fixing capability. Chokecherry on the other hand is mildly palatable to browsers but is only moderately tolerant to browsing and prefers a moist habitat. Saskatoons can tolerate moist or dry conditions, and they are highly palatable to browsers and highly browse-tolerant (Hardy BBT 1989).

Grasses, herbs and small shrubs can also compete with saskatoons in young stands. Thus, any vegetation management plan needs to address this issue if burning or clear cutting are included in the plan. Since there are some other options, it is possible that these problems may be avoided in some cases.

An additional problem with saskatoon regeneration in open and grassy areas is that of rodent damage. In northeastern Alberta, a study was done to evaluate the success rate of establishing several shrubs and trees in response to a variety of treatments of grass and legume cover for reclamation purposes. On the non-scarified plots rodent damage by voles (*Microtus* sp.) to young woody plants was very high with *A. alnifolia* receiving the most damage at 98% of the planted seedlings. They were completely severed at the ground level by the voles. However, the saskatoons, the aspen and the alder readily resprouted where sufficient root stock remained with saskatoons having the best survival rate of 71 to 93% across all the treatments after two years (Fedkenheuer 1980). Thus, although the rodents caused a set back in the establishment of the saskatoons, the effects of their browsing were not permanent.

As mentioned in Results, the aspen saplings were either absent or heavily damaged from broken trunks and browsing in the open and shrubby areas of the park. A study in Alaska by Oldemeyer *et al.* (1977) showed that alder and willow were the best summer browse for moose, but that in the winter aspen ranked as the best moose browse. Although it is dangerous to extrapolate

these data to Saskatoon Island, it does point to a possible mechanism for maintaining the extensive saskatoon coverage in the park. Other studies indicate that moose populations decrease after browse grows beyond their reach at about 2.4 m in height, but moose will break down aspen saplings up to 10 cm in diameter to obtain browse if it is out of their reach (Telfer & Cairns 1978) as was evidenced in our study. Rolley and Keith (1980) reported that, "aspen stands less than 10m tall are preferred habitat for moose in Alberta". In another study Cairns and Telfer (1980) found that moose spend most of their time in sites dominated by shrubs even though young aspen stands are preferred as early winter feeding grounds. It has also been found that snowshoe hare and grouse prefer willow and then aspen for winter feeding (Bryant & Kuropat 1980). It is thought that the lower resinous content of these plants is an important factor in their selection.

It appears from our observations and from the literature that during the winter moose, snowshoe hare, and probably deer feed on the preferred aspen saplings and in the process destroy many of them. They then move on to feed on the saskatoon shrubs because of their proximity, abundance and palatability. What this suggests is that the main competitive advantages for saskatoons over aspen, wolf willow and choke cherry are their ability to tolerate both moisture and drought combined with their high tolerance for browsing by a variety of herbivores. For an excellent discussion of wildlife issues in aspen forests see Peterson and Peterson 1992.

Our conclusion is that the subclimax upland tall shrub community on Saskatoon Island has been perpetuated by two major factors. These are 1) a long term favourable moisture and climate regime, and 2) a delicate balance between young aspen, saskatoon shrubs and the browsing animals that depend upon them for year around sustenance.

Recommendations

Ecosystem Management

The general approach to managing Saskatoon Island Provincial Park should be that of ecosystem management. Such an approach is vital to maintaining the ecological integrity of the park. Although planning for human use is extremely important, the primary ecological goal of the park should be to sustain the natural ecological processes and the genetic, species and ecosystem diversity of the park well into the future. The park vegetation appears to have been relatively stable for a very long time without any specific ecosystem management objectives so the question arises as to whether any management goals are necessary. Won't the park just go on as it always has?

The answer to this is that, well, it might be, but without ecosystem management objectives for the park, the the ever-increasing demands for greater use of the park, increasing population pressures in the Grande Prairie area, and the need for more development could compromise the park's ecological integrity.

Because there is still so much that is not completely understood about our forests and shrubland ecosystems, especially on Saskatoon Island where relatively little research has been done, adaptive management must be integrated into the management plan. This will require some systematic research and long term monitoring with accurate reporting and a place where data can be stored and available for future reference.

At this stage, we are only suggesting the possible management strategies that might be used to move toward an ecosystem management approach for the park.

Only two major vegetation types have been addressed in this report and a complete vegetation management protocol for the park awaits some decisions about park direction and the availability of funding for follow-up actions.

As with the rest of this report, our recommendations are divided into two parts, the forest communities and the upland shrublands.

Forested Areas

Regeneration of aspen

Before dealing with regeneration of aspen, an immediate concern that must be addressed is the removal of standing, dangerous, trees in Zone B. Both plot and walk-through observations identified a number of these trees dangerously close to the parking and camping areas. If these trees are not removed in the very near future they should certainly be monitored for the onset of decay which would leave them prone to breakage in any kind of wind.

With the dangerous trees removed, Zone B in fact does not require any further tending as there is adequate suckering through most of the zone. The recommendations following are therefore directed towards the other five zones, A, C, D, E and F.

Recruitment

Recruitment Strategy

The recruitment strategy is a plan that outlines the organization's approach to attracting, selecting, and hiring new employees. It is a key component of the human resources management system and is closely linked to the organization's overall business strategy. The recruitment strategy should be based on the organization's needs, the labor market, and the organization's culture. It should also be based on the organization's budget and the time available for recruitment. The recruitment strategy should be developed in consultation with the senior management and the human resources department. It should be reviewed and updated regularly to ensure that it remains relevant and effective.

Recruitment Process

The recruitment process is the series of steps that an organization follows to attract, select, and hire new employees. It typically starts with the identification of a need for a new employee, followed by the development of a job description and the posting of the job. The next steps are the recruitment of applicants, the selection of the best candidate, and the hiring of the candidate. The recruitment process should be designed to be efficient and effective, and it should be based on the organization's recruitment strategy. It should also be based on the organization's culture and the labor market. The recruitment process should be reviewed and updated regularly to ensure that it remains relevant and effective.

2

Option I - 'no action'

As with any management project, one must always consider the repercussions of taking 'no action'. Following are the reasons why we believe taking no action would not be appropriate:

1. Suckering, if it does occur, will not commence until the existing mature aspen stands begin to decay and break up.
2. It is by no means certain that there will be successful aspen regeneration at that time. Factors which would prevent successful suckering are:
 - Roots of mature aspen may have begun to decay.
 - Soil temperatures may not increase sufficiently until most of the stand has gone.
 - Amount of light reaching the forest floor may not be sufficient until most of the stand has gone.
 - The space created as individual trees die may simply be taken over by the aggressive herb and shrub vegetation which currently occupies large areas in the Park. A similar scenario was encountered by Lux (1998) in Manitoba.

Option II - create a disturbance

Fire

In the natural forest, aspen stands were maintained by fire which removed the overstorey and simultaneously created the other conditions necessary for production and survival of suckers (Van Wagner, 1990). Biologically, the aspen zones of the park could be regenerated by fire. However, it would require an intense fire to remove the overstorey trees, thus promoting the conditions needed for successful suckering. While the decision on the regeneration method will be made by Parks management, it would seem that although regeneration by fire is biologically feasible, it would probably not be politically acceptable in a recreation area. Another potential drawback to the use of fire is that the exact outcome, in terms of suckering, is difficult to predict (McRae, 1985).

Harvest

In the managed forest of the 1990's control programs have largely removed fire as a disturbance which could perpetuate aspen stands. In the absence of fire the most effective regeneration technique is creation of a disturbance through harvesting. Aspen biology dictates that the harvesting method must remove the greater part of the canopy cover to result in successful regeneration. This can be done by either (i) a partial-cut system with retention of a few scattered, vigorous, stems or (ii) a clear-cut harvesting system.

Application of a partial-cut system to Saskatoon Island Park.

The term 'partial-cut' is not used here in the traditional sense where the retained trees were the source of regeneration. Rather it is used in the sense of a 'retention' system. A major drawback in applying partial-cut systems to conifers such as spruce is the danger of windthrow. This drawback does not apply to aspen as it is a relatively windfirm species (Jones and DeByle, 1985). Given the light requirements for successful regeneration, only the absolute minimum number of stems should be retained. Keeping 20 trees per hectare would translate to a spacing of about 22 metres between retained trees. This strategy should allow sufficient light to ensure survival of suckering while the retained trees would serve as habitat for some types of wildlife. As the trees age they will become snags which will provide habitat for cavity-dwelling wildlife. Stelfox (1988) suggests 24 trees per hectare as a suitable number to provide habitat for cavity-dwelling wildlife. For better wildlife usage, these trees might be retained in clumps rather than as individual trees. The risk posed by dead standing trees should be kept in mind and constant monitoring would be needed to maintain a safe environment. If this route were followed, temporary elimination of existing, aggressive, competing ground vegetation would also be necessary to ensure early survival of the suckers. Given that there are seven separate areas to be dealt with (Zone E could be handled as two sub-zones), the treatment could be implemented in six stages, spaced over either six or twelve years. The twelve-year period would allow for better monitoring and for easier modifications of the treatment, if any were needed. Sequencing of the treatment could take account of the marginal age and health differences between zones.

Application of a clear-cut system to Saskatoon Island Park

Experience of operational foresters has shown that the most successful regeneration of aspen is achieved by clear-cut harvesting (Peterson and Peterson, 1992). The obvious advantage of clear-cutting is that the regenerating aspen would receive the maximum amount of light. As with the partial-cut system the more competitive ground vegetation would need to be controlled, at least temporarily. The time frame and sequencing for a clear-cut treatment could be the same as outlined for the partial-cut system, that is, either a six or twelve year window. A possible variant of this system would be to implement the clear-cut in strips, anything from 30 to 50 metres wide. Given the small size of most of the zones, strip-cutting might only apply to the eastern end of Zone D and the western end of Zone E. This procedure would provide some cover for wildlife. Also, if this

The first part of the paper discusses the importance of the study. It highlights the need for a comprehensive understanding of the subject matter. The author emphasizes that this research is crucial for advancing the field and addressing the challenges that have been identified. The paper then proceeds to outline the methodology used in the study, which involves a combination of qualitative and quantitative approaches. The data collection process is described in detail, and the analysis of the results is presented. The author concludes by summarizing the findings and discussing their implications for future research and practice.

The second part of the paper focuses on the theoretical framework. It explores the various theories and models that have been developed in the field. The author discusses the strengths and weaknesses of these theories and how they have been applied in previous studies. This section also includes a critical evaluation of the existing literature and identifies the gaps that the current study aims to fill. The theoretical framework is then used to guide the research and inform the interpretation of the results.

The third part of the paper presents the results of the study. It includes a detailed description of the data and the statistical analysis that was performed. The author discusses the significance of the findings and how they relate to the research objectives. This section also includes a discussion of the limitations of the study and the potential for future research. The paper concludes with a final summary of the key findings and a statement of the author's conclusions.

The fourth part of the paper discusses the implications of the study. It explores the practical applications of the findings and how they can be used to inform policy and practice. The author also discusses the broader implications of the study for the field and for society. This section includes a discussion of the ethical considerations that were taken into account during the research process. The paper concludes with a final statement of the author's conclusions and a call to action for further research.

The fifth part of the paper is a conclusion. It summarizes the main findings of the study and discusses their significance. The author also reflects on the research process and the challenges that were encountered. This section includes a final statement of the author's conclusions and a call to action for further research.

The sixth part of the paper is a bibliography. It lists all of the sources that were used in the study. This section includes a list of books, articles, and other publications that are relevant to the research. The bibliography is organized alphabetically by the author's name.

method were used, the strips should be cut so that newly exposed strips would receive the maximum sunlight.

Introduction of white spruce

In the early 1980's the Alberta Government attempted to convert mixedwood stands to conifer by clearing many aspen stands and planting them to white spruce. The result was that the aspen quickly suckered back to form a canopy over the spruce. Today, some twenty years later, these stands provide an excellent example of mixedwood, with the white spruce, being a shade-tolerant species that thrives underneath the aspen canopy. Eventually, over a 60–80 year period, the white spruce will grow through the aspen canopy and these former aspen stands, will become white spruce stands.

At Saskatoon Island Provincial Park it would be relatively easy to develop some mixedwood stands, with white spruce as an understory to the aspen canopy. All that is required is to plant white spruce in areas where mature aspen has been removed. The same scenario that is occurring in the northern forests described above would undoubtedly play itself out in the Park. Thus in these artificially-created mixedwood stands, the perpetuation of the aspen might become a problem particularly with the young aspen providing ideal browse habitat for the local moose population. Frequent monitoring and the use of adaptive management to maintain some aspen stands will be essential.

Upland shrub communities

Saskatoon Island Provincial Park is rather unique in the Peace Parkland because of the extensive and long-lasting saskatoon shrub community. This community is poorly understood and an experimental approach to management of this ecosystem is essential to its long term sustainability.

The main management objectives for the upland shrub ecosystems are:

- 1) To rejuvenate the saskatoon shrubs (or clones) and eliminate or at least reduce the frequency of diseases that threaten the shrub community by working toward a more balanced array of age classes. This will require the removal of some (but not all) of the oldest and most dense shrub patches over a period of 20 years to allow for regeneration of young saskatoons through the process of suckering. It will also involve removal of diseased plants and/or plant parts.

- 2) To conserve species diversity by maintaining the variation in species and community types present in the upland shrub communities by maintaining the varied landscape.

Experimental approach

Because of the difficulty of zoning the upland shrub communities due to the variety of types and ages present combined with the small patch sizes, we suggest that the park obtain a recent aerial photograph (no earlier than 1995) of Saskatoon Island to map and analyse the small patches in the upland shrub communities. This is because not only is it extremely difficult to map these small patches without some extensive GPS work, but when we did map the shrub density from the 1971 and 1987 aerial photos, we found some major differences in the distribution of shrub density between the two photos. These differences may be attributed to a number of ecological factors and to differences in the quality of the photos. Figures 8 & 9 (transparency overlays to Figure 2) show our analysis of the differences in shrub density between the two photos. If this much difference in shrub density actually occurred between 1971 and 1987, then we suspect that between 1987 and 1999 there have been some important changes in shrub density and composition which need to be clarified. With a new air photo the shrub density patches could be mapped to better represent current conditions, and the application of an ecosystem management plan to this small landscape would be easier. The more accurate map of current conditions would permit the preparation of a good working plan for the manipulation of the various shrub and meadow patches identified in the park.

Since all of the larger upland woody species produce suckers, competition among these species may be an important factor in attempting to rejuvenate the saskatoon community. Because there is little evidence that aspen can out-compete saskatoons on Saskatoon Island (see Discussion), the expansion of aspen into saskatoon stands is fairly unlikely unless environmental conditions are altered to allow their expansion. Rising water levels or long term climatic changes might tip the balance in favour of aspen, wolf willow and/or choke cherry. In the event of a long-lasting drought or a major natural disturbance such as a very hot 'crown' fire, the entire park could be set back to a much earlier successional stage such as grassland.

If we assume current environmental conditions will be maintained well into the future, an experimental design for rejuvenating the saskatoons in the upland shrubland might include the following elements:



Fire

Historically, fire has been an important natural disturbance in the Peace Parkland and throughout the boreal forest. However, results from the research conducted by Ken Zurfluh (1999) in the early 1980's on Saskatoon Island, indicate that burning may not be the best choice for rejuvenation of the saskatoon stands. Also, park visitors may not find burning the saskatoon areas an acceptable activity. One or two small experimental controlled burn plots in the very old and diseased communities followed by intensive monitoring might be an acceptable and useful alternative to a full blown fire protocol. However, effects of fires of different intensities can have entirely different consequences so that it would be imperative that the fire intensity be controlled and measured and that appropriate benchmarks be in place. At this time, therefore, we do not recommend a large scale experimental burning protocol for the park.

Clearcutting

Cutting all woody stems right to the ground in small patches ($>100\text{m}^2$) in the oldest and /or tallest saskatoon thickets which may include some wolf willow and/or choke cherry, could be used as a tool to emulate fire as a natural disturbance. In some cases the understorey could be left undisturbed to compare with other treatments to see what vegetation survives and/or regenerates. The best time for this activity is in the early spring right after the snow has melted from the area. The severity of a fire usually determines how much woody debris is left and the amount of exposed mineral soil. These effects could be simulated to a certain degree by controlling the amount of branches left on the site after 'logging' and mechanical soil disturbance. By comparing the results with control plots we could learn if fungal diseases are more likely to recur on young shrubs as a result of woody debris left on the ground.

Soil Treatments

Other aspects of this study might include the manipulation of the soil. This could include mechanical disturbance to break up the underground stolons of the saskatoons and to expose mineral soil, and the inoculation of saskatoon mycorrhizae into the soil. This study could provide some useful information about nutrient uptake and growth of seedlings and identify any competitive advantage of the saskatoons over other suckering plants and grasses.

Inoculating open areas that are primarily colonized by grasses, herbs and low shrubs with saskatoon mycorrhizal roots might also be considered if expanding the saskatoon cover is an overall goal for the park. However, there is very little native grassland remaining in the Peace country today, and the open areas might be

better served by restoring them to a native grassland community. These restorations could be used as demonstration sites to educate visitors and increase their interest in the ecology of the park.

Partial cutting

This treatment would involve the removal of some saskatoon stems particularly in the younger and medium-aged thickets as a thinning tool. A three to six foot circle around each selected cluster of stems would provide more light and drying air to the lower branches and the soil. Because fungal diseases thrive in shaded, damp areas, this might limit environmental conditions required for diseases such as black leaf. It might also encourage more branching at lower reachable levels for berry pickers. Grass competition could become a problem here but that would also provide increased species diversity in that plot and help to maintain the spacing between clumps.

Browsing experiments

Two approaches could be used to address the effects of browse on the saskatoon communities. The first is through pruning and the second is by installing browse enclosures.

- Pruning of different aged plots to simulate browsing by ungulates. This should be done in older thickets that are seldom used by large ungulates, medium aged patches and even young shrub patches where both browsers and human berry pickers tend to have some impact on the shrubs).
 - 1) Prune diseased material from the tips of branches and remove the branches
 - 2) Cut tops out of large stems in old thickets to simulate the effects of moose winter breakage.
- Build some small enclosure plots ($50\text{--}100\text{ m}^2$) in prime browsing habitats. These plots would have to be very sturdy and be able to exclude moose, deer and snowshoe hare. Elk or bison range fencing would probably be adequate but a small gauge wire would be required to exclude snowshoe hare. Although long-term monitoring is imperative to provide an understanding of the wild saskatoon growth dynamics in relation to wildlife browsing, monitoring should be undertaken on an annual basis because wildlife tend to behave differently from year-to-year due to changes in population sizes and differing environmental conditions.

If time or funding precludes the implementation of all the above experiments in the saskatoon stands, the literature and data we have available to us at the time of writing indicate that the most critical and useful information could be obtained from the clearcutting and the

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browsing experiments (both pruning and exclosure). Therefore, we suggest that part of any initial funding go toward these two types of treatments.

General considerations

Each of the experimental treatments described in this report could provide valuable information for use in an adaptive management process. A monitoring protocol that is appropriate to each experimental treatment and for the control (benchmark) stands is absolutely essential to the success of the project. Costs must also be included in the overall vegetation management plan. For example additional costs will be necessary for hiring some part-time, trained personnel not only to set up the experimental treatments but also to collect and record data from the monitoring phase of the project. Cost of

materials, especially fencing, must also be included in the budget.

Finally, the experimental design should follow an ecosystem management process. When single species conservation (fine filter approach) is the only objective then the primary concern is for the preservation of that species, such as we might consider in the protection of the uncommon striped coral root in the park. Although we have a specific interest in saskatoons and aspen, they are abundant and ubiquitous and the dominant canopy species in the park. Thus, the overall ecosystem management objective is at the larger landscape scale and it is concerned with the sustainability of the many habitats that are a part of these ecosystems (coarse filter approach) to insure overall ecological integrity and biodiversity on Saskatoon Island. Adaptive management with effective research and monitoring protocols will be essential to the accomplishment of the ecosystem management goal and the success of the project.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent and reliable data collection processes to support effective decision-making.

3. The third part of the document describes the different types of reports and dashboards generated from the data. It explains how these tools provide valuable insights into the organization's performance and help identify areas for improvement.

4. The fourth part of the document discusses the challenges and limitations of data analysis. It acknowledges that while data is a powerful tool, it is not infallible and requires careful interpretation and validation.

5. The fifth part of the document provides a summary of the key findings and conclusions. It reiterates the importance of data-driven decision-making and the need for ongoing monitoring and evaluation of the organization's performance.

6. The sixth part of the document discusses the future of data analysis and the potential for new technologies to enhance the organization's capabilities. It mentions the growing importance of artificial intelligence and machine learning in data analysis.

7. The seventh part of the document provides a list of references and sources used in the document. It includes books, articles, and other resources that provide additional information on the topics discussed.

8. The eighth part of the document provides a list of appendices and supplementary materials. These include additional data, charts, and tables that support the main text of the document.

9. The ninth part of the document provides a list of contact information for the authors and other relevant parties. This includes email addresses and phone numbers for those who may wish to contact the authors for more information.

10. The tenth part of the document provides a list of acknowledgments and thanks. It expresses gratitude to the individuals and organizations that provided support and assistance during the research and writing process.

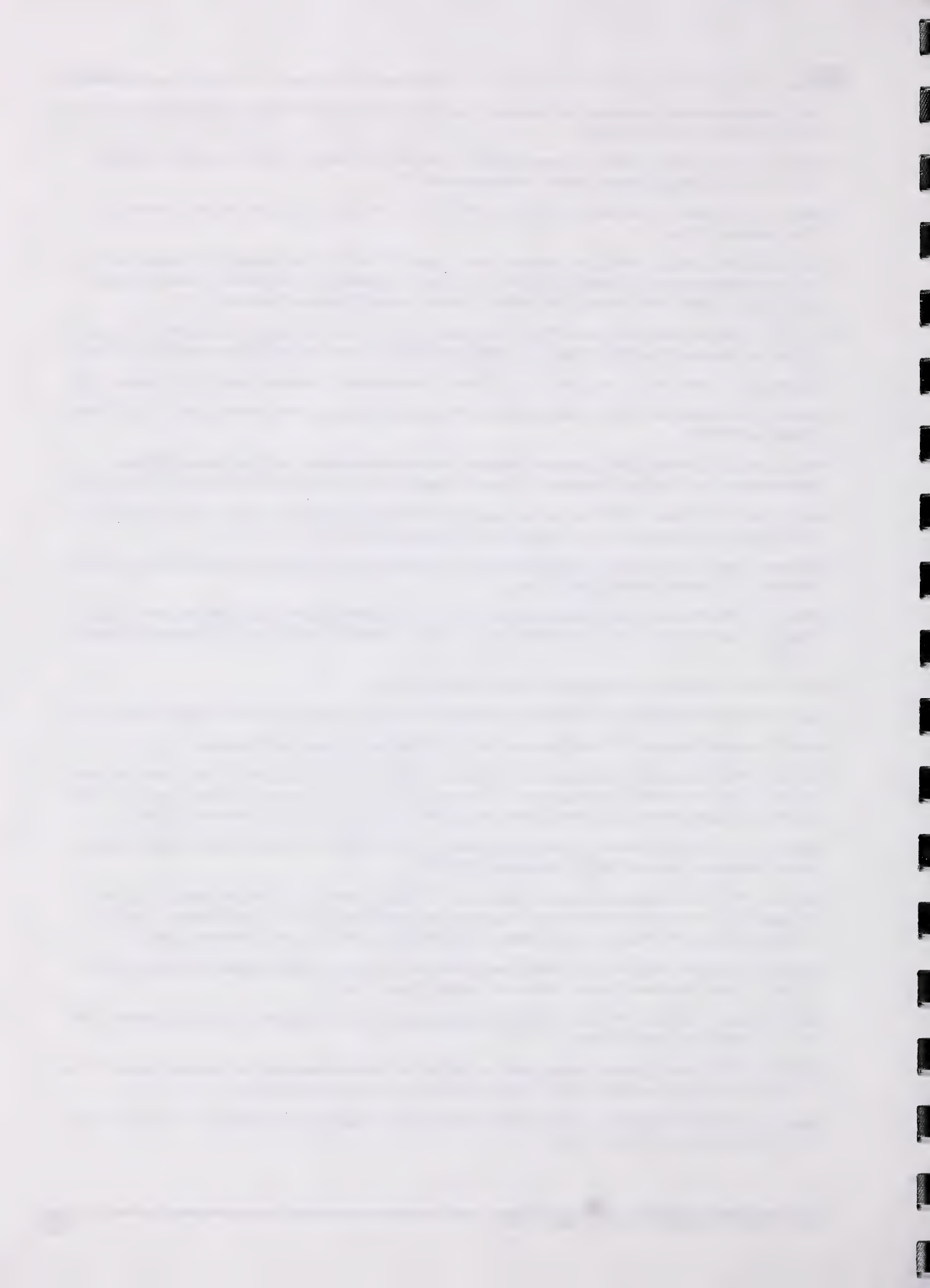
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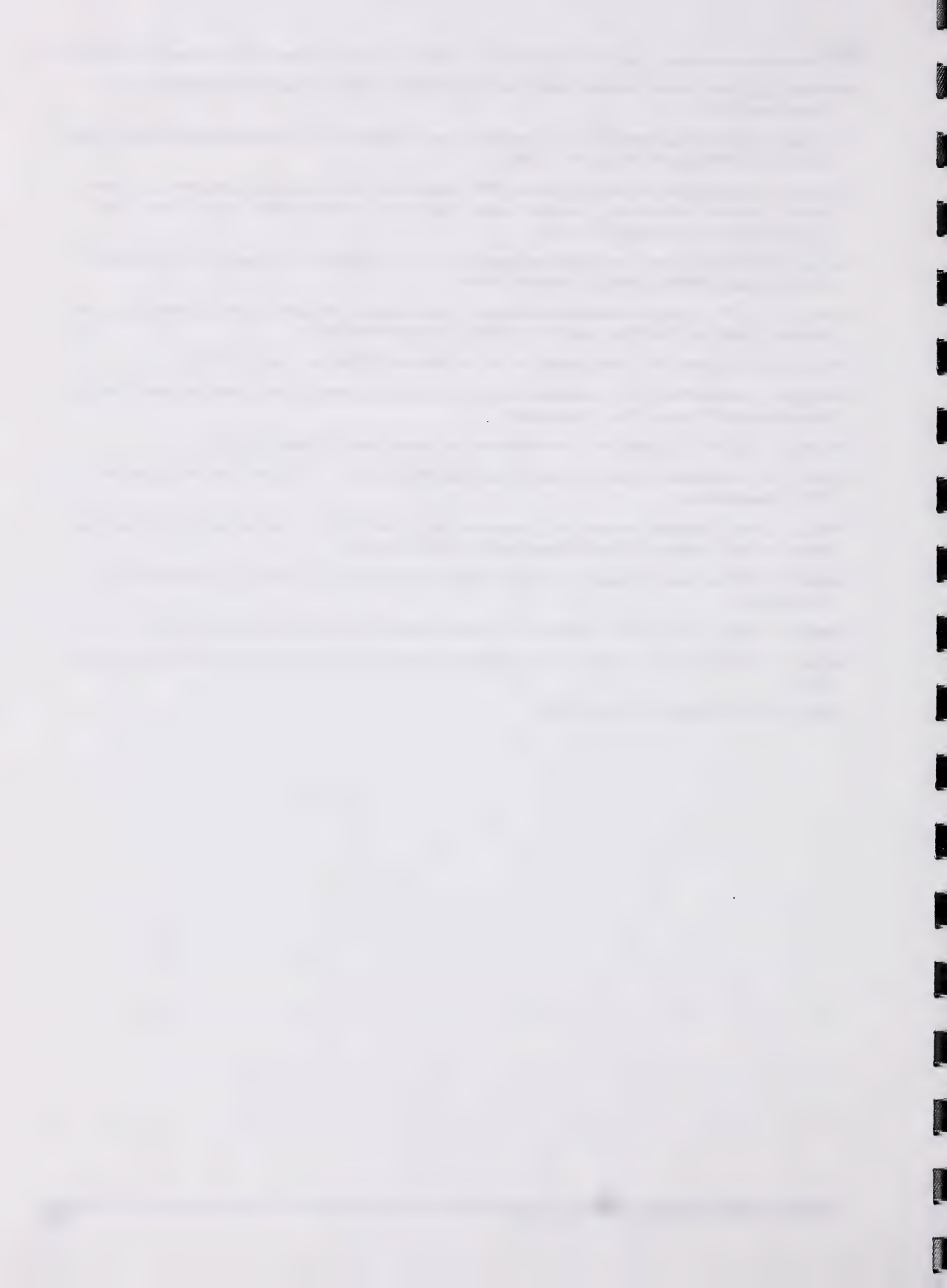
Literature class

The first part of the class was devoted to a discussion of the poem "The Waste Land" by T.S. Eliot. The students were asked to identify the main themes and symbols in the poem. They discussed the poem's structure and its historical context. The second part of the class was a reading of "The Waste Land" aloud. The students were then asked to write a short paragraph about their favorite part of the poem. The third part of the class was a discussion of the poem's language and style. The students were asked to identify the poem's main themes and symbols. They discussed the poem's structure and its historical context. The fourth part of the class was a reading of "The Waste Land" aloud. The students were then asked to write a short paragraph about their favorite part of the poem. The fifth part of the class was a discussion of the poem's language and style. The students were asked to identify the poem's main themes and symbols. They discussed the poem's structure and its historical context. The sixth part of the class was a reading of "The Waste Land" aloud. The students were then asked to write a short paragraph about their favorite part of the poem. The seventh part of the class was a discussion of the poem's language and style. The students were asked to identify the poem's main themes and symbols. They discussed the poem's structure and its historical context. The eighth part of the class was a reading of "The Waste Land" aloud. The students were then asked to write a short paragraph about their favorite part of the poem. The ninth part of the class was a discussion of the poem's language and style. The students were asked to identify the poem's main themes and symbols. They discussed the poem's structure and its historical context. The tenth part of the class was a reading of "The Waste Land" aloud. The students were then asked to write a short paragraph about their favorite part of the poem.

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Appendix I

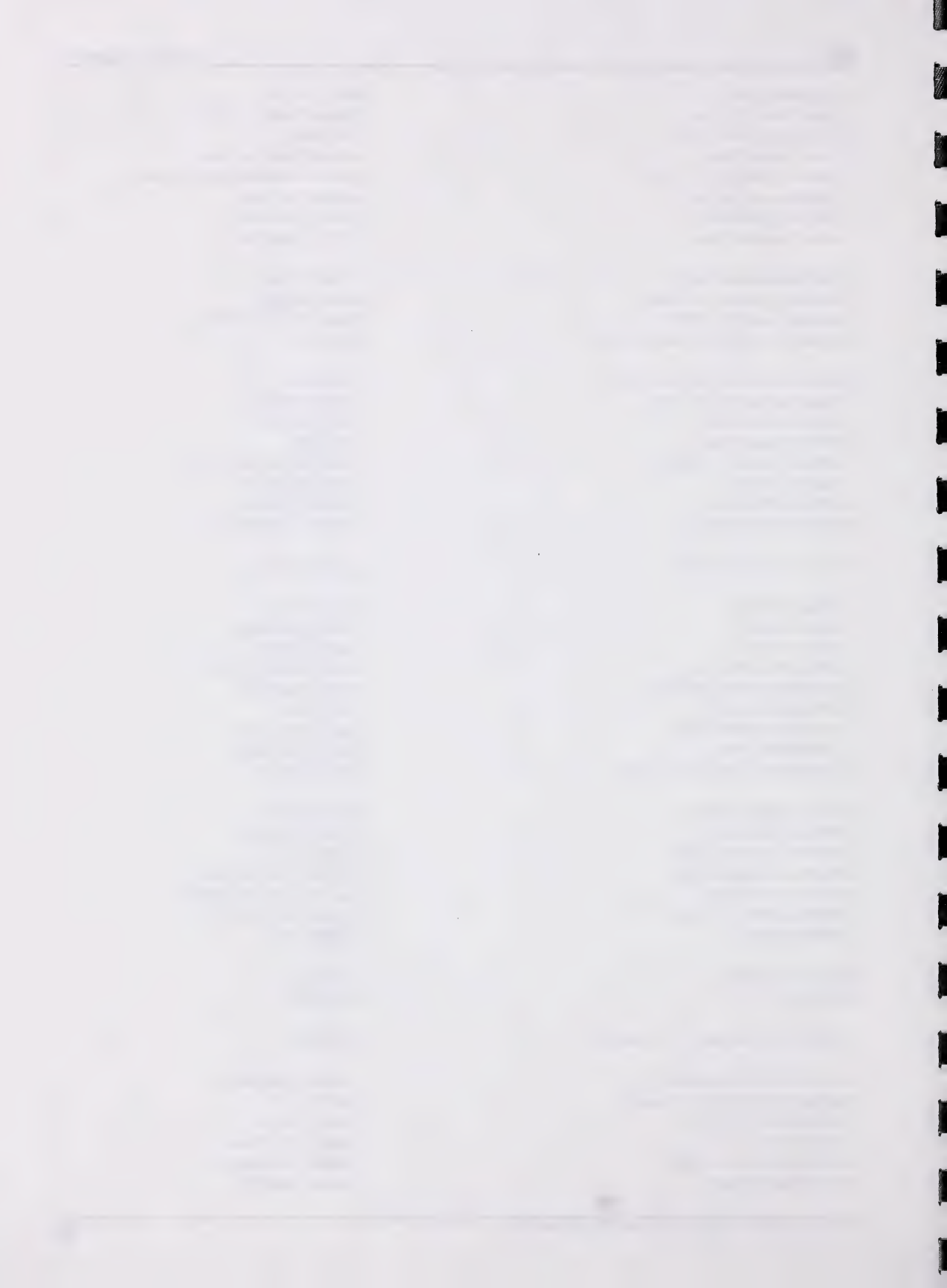
Vascular Plant Species Occurring in Saskatoon Island Provincial Park in 1998.

Latin name	Common name
<i>Achillea millefolium</i> L.	common yarrow
<i>Achillea sibirica</i> Ledeb.	smooth fleabane
<i>Actaea rubra</i> (Ait) Willd.	baneberry
<i>Agastache foeniculum</i> (Pursh) Ktze.	giant hyssop
<i>Agropyron cristatum</i> (L.) Gaertn.	crested wheatgrass
<i>Agropyron repens</i> (L.) Beauv.	quack grass
<i>Agroseris glauca</i> (Pursh) Raf.	large flowered false dandelion
<i>Agrostis scabra</i> Willd.	rough hair grass
<i>Alisma plantago-aquatica</i> L.	broad leaved water plantain
<i>Alopecurus aequalis</i> Sobol.	short awned foxtail
<i>Amelanchier alnifolia</i> Nutt.	saskatoon
<i>Anemone canadensis</i> L.	Canada anemone
<i>Anemone multifida</i> Poir.	cut-leaved anemone
<i>Anemone patens</i> L.	prairie crocus
<i>Antennaria parviflora</i> Nutt.	small leaved pussy toes
<i>Aralia nudicaulis</i> L.	wild sarsaparilla
<i>Arnica chamissonis</i> Less.	meadow arnica
<i>Artemisia frigida</i> Willd.	pasture sage
<i>Artemisia ludoviciana</i> Nutt.	prairie sage
<i>Aster borealis</i> (T. & G.) Prov.	marsh aster
<i>Aster ciliolatus</i> Lindl.	Lindley's aster
<i>Aster ericoides</i> L.	tufted white prairie aster
<i>Aster hesperis</i> A. Gray	western willow aster
<i>Astragalus americanus</i> (Hook) M.E. Jones	American milk vetch
<i>Astragalus dasyglottis</i> Fisch. ex DC.	purple milk vetch
<i>Beckmannia syzigachne</i> Steud. Fern.	slough grass
<i>Bidens cernua</i> L.	nodding beggar-ticks
<i>Bromus ciliatus</i> L.	Fringed brome
<i>Bromus inermis</i> Leyss.	northern brome
<i>Calamagrostis canadensis</i> (Michx.) Beauv.	marsh reed grass
<i>Calamagrostis inexpansa</i> A. Gray	northern reed grass
<i>Calla palustris</i> L.	water arum
<i>Campanula rotundifolia</i> L.	common harebell
<i>Capsella bursa-pastoris</i> (L.) Medic.	shepherd's purse
<i>Carex acnea</i> Fern.	bronze sedge
<i>Carex aurea</i> Nutt.	golden sedge
<i>Carex sartwellii</i> Dewey	Sartwell's sedge
<i>Carex utriculata</i>	beaked sedge
<i>Cerastium arvense</i> L.	field mouse-eared chickweed

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<i>Chenopodium album</i> L.	lamb's quarters
<i>Cirsium arvense</i> (L.) Scop.	Canada thistle
<i>Cirsium vulgare</i> (Savi) Ten.	bull thistle
<i>Collomia linearis</i> Nutt.	narrow leaved collomia
<i>Commandra umbellata</i> (L.) Nutt.	pale commandra/bastard toadflax
<i>Corallorhiza maculata</i> Raf.	spotted coral root
<i>Corallorhiza striata</i> Lindl.	striped coral root
<i>Cornus stolonifera</i> Michx.	red osier dogwood
<i>Danthonia intermedia</i> Vasey	timber oat grass
<i>Deschampsia caespitosa</i> (L.) Beauv.	tufted hair grass
<i>Descurainia sophia</i> (L.) Webb	flixweed/tansy mustard
<i>Disporum trachycarpum</i> (S. Wats.) B. & H.	fairy bells
<i>Elaeagnus commutata</i> Bernh. ex Rydb.	wolf willow
<i>Eleocharis palustris</i> (L.) R. & S.	creeping spike rush
<i>Elymus innovatus</i> Beal	hairy wild rye
<i>Epilobium angustifolium</i> L.	fireweed
<i>Epilobium glandulosum</i> Lehm.	purple leaved willow herb
<i>Equisetum arvense</i> L.	common horsetail
<i>Erigeron glabellus</i> Nutt.	smooth Fleabane
<i>Erysimum cheiranthoides</i> L.	wormseed mustard
<i>Fragaria virginiana</i> Duchesne	wild strawberry
<i>Galeopsis tetrahit</i> L.	hemp nettle
<i>Galium boreale</i> L.	northern bedstraw
<i>Galium trifidum</i> L.	small bedstraw
<i>Galium triflorum</i> Michx.	sweet scented bedstraw
<i>Gentianella amarella</i> (L.) Borner	northern gentian
<i>Geum aleppicum</i> Jacq.	yellow avens
<i>Geum macrophyllum</i> Willd.	large leaved avens
<i>Geum triflorum</i> Pursh	three flowered avens
<i>Glyceria grandis</i> S. Wats. ex A. Gray	tall manna grass
<i>Habenaria viridis</i> (L.) R. Br.	bracted orchid.
<i>Hedysarum alpinum</i> L.	alpine hedysarum
<i>Heracleum lanatum</i> Michx.	cow parsnip
<i>Heuchera richardsonii</i> R. Br.	Richardson's alum root
<i>Hieracium umbellatum</i> L.	narrow leaved hawkweed
<i>Hierochloa odorata</i> (L.) Beauv.	common sweet grass
<i>Hordeum jubatum</i> L.	foxtail barley
<i>Juncus balticus</i> Willd.	arctic rush
<i>Juncus bufonis</i> L.	toad rush
<i>Koeleria cristata</i> (Ledeb.) J. A. Schultes f.	june grass
<i>Lactuca pulchella</i> (Pursh) DC.	common blue lettuce
<i>Lappula squarrosa</i> (Retz.) Dumort.	blue bur
<i>Lathyrus ochroleucus</i> Hook.	creamy peavine
<i>Lemna minor</i> L.	common duckweed
<i>Lepidium densiflorum</i> Schrad.	common peppergrass
<i>Lilium philadelphicum</i> L.	western wood lily



<i>Linnæa borealis</i> L.	twinflower
<i>Lomatogonium rotatum</i> (L.) Fries	marsh felwort
<i>Lonicera dioica</i> L.	twining honeysuckle
<i>Lonicera involucrata</i> (Richards.) Banks	bracted honeysuckle
<i>Lonicera tatarica</i> L.	Tatarian honeysuckle
<i>Maianthemum canadense</i> Desf.	wild lily-of-the-valley
<i>Matricaria matricariodes</i> (Less.) Porter	pineappleweed
<i>Medicago sativa</i> L.	alfalfa
<i>Melilotus alba</i> Desr.	white sweet clover
<i>Melilotus officinalis</i> (L.) Lam.	yellow sweet clover
<i>Mentha arvensis</i> L.	wild mint
<i>Mertensia paniculata</i> (Ait.) G. Don.	tall lungwort/tall bluebells
<i>Mitella nuda</i> L.	bishop's cap
<i>Moehringia laterifolia</i> (L.) Fenzl.	blunt leaved sandwort
<i>Monarda fistulosa</i> L.	wild bergamot
<i>Onobrychis viciaefolia</i> Scop	sanfoin
<i>Osmorhiza depauperata</i> Philippi	spreading sweet cicely
<i>Oxytropis splendens</i>	showy locoweed
<i>Petasites sagittatus</i>	arrow leaved coltsfoot
<i>Phalaris arundinacea</i> L.	reed canary grass
<i>Phleum pratense</i> L.	timothy
<i>Picea glauca</i> (Moench) Voss	white spruce
<i>Plantago major</i> L.	common plantain
<i>Poa palustris</i> L.	fowl bluegrass
<i>Poa pratensis</i> L.	Kentucky bluegrass
<i>Polygonum</i> sp	water smartweed
<i>Populus balsamifera</i> L.	balsam poplar
<i>Populus tremuloides</i> Michx.	aspen poplar
<i>Potentilla anserina</i> L.	silverweed
<i>Potentilla arguta</i> Pursh	white cinquefoil
<i>Potentilla gracilis</i> Dougl. ex Hook.	graceful cinquefoil
<i>Potentilla norvegica</i> L.	rough cinquefoil
<i>Potentilla pensylvanica</i> L.	prairie cinquefoil
<i>Prunus virginiana</i> L.	Chokecherry
<i>Pyrola asarifolia</i> Michx.	Common pink wintergreen
<i>Pyrola elliptica</i> Nutt.	white wintergreen
<i>Pyrola virens</i> Schweig.	green wintergreen
<i>Ranunculus abortivus</i> L.	small-flowered buttercup
<i>Ranunculus acris</i> L.	meadow buttercup
<i>Ranunculus cymbalaria</i> Pursh	shore buttercup
<i>Ranunculus macounii</i> Britt.	Macoun's buttercup
<i>Ranunculus sceleratus</i> L.	celery leaved buttercup
<i>Ribes oxycanthoides</i> L.	northern gooseberry
<i>Rorippa islandica</i> (Oeder) Borbes	marsh yellow cress
<i>Rosa acicularis</i> Lindl.	prickly rose
<i>Rosa woodsii</i> Lindl.	common wild rose
<i>Rubus idaeus</i> L.	wild red raspberry
<i>Rubus pubescens</i> Raf.	dewberry
<i>Rumex occidentalis</i> S. Wats.	western dock



<i>Salix bebbiana</i> Sarg.	neaked willow/Bebb's willow
<i>Salix exigua</i> Nutt.	sandbar willow
<i>Sanicula marilandica</i> L.	snake root
<i>Schizachne purpurescens</i> (Torr.) Swallen	false melic/purple oatgrass
<i>Scirpus lacustris</i> L.	common great bullrush
<i>Scutellaria galericulata</i> L.	marsh skullcap
<i>Senecio eremophilus</i> Richard	cut-leaved ragwort
<i>Senecio pauperculus</i> Michx.	balsam groundsel
<i>Senecio vulgaris</i> L.	common groundsel
<i>Shepherdia canadensis</i> (L.) Nutt.	shrubby cinquefoil
<i>Sisyrinchium montanum</i> Greene	common blue eyed grass
<i>Smilacena racemosa</i> (L.) Desf.	false Solomon's seal
<i>Smilacena stellata</i> (L.) Desf.	star-flowered Solomon's seal
<i>Solidago canadensis</i> L.	Canada goldenrod
<i>Sonchus arvensis</i> L.	perennial sow thistle
<i>Spartanium</i> sp	bur-reed
<i>Stachys palustris</i> L.	marsh hedge nettle
<i>Stellaria longifolia</i> Muhl.	long-leaved chickweed
<i>Stellaria longipes</i> Goldie	long-stalked chickweed
<i>Stellaria media</i> (L.) Cyrill.	common chickweed
<i>Stipa curtiseta</i> (A.S. Hitchc.) Barkworth	porcupine grass
<i>Symphoricarpos albus</i> (L.) Blake	common snowberry
<i>Symphoricarpos occidentalis</i> Hook.	buckbrush/western snowberry
<i>Taraxacum officinale</i> Weber	common dandelion
<i>Thalictrum venulosum</i> Trel.	veiny meadow rue
<i>Thlaspi arvense</i> L.	penny cress/stinkweed
<i>Trifolium hybridum</i> L.	alsike clover
<i>Trifolium pratense</i> L.	red clover
<i>Trifolium repens</i> L.	white Dutch clover
<i>Typha latifolia</i> L.	common cattail
<i>Urtica dioica</i> L.	stinging nettle
<i>Utricularia vulgaris</i> L.	common bladderwort
<i>Vaccinium caespitosum</i> Michx.	dwarf blueberry
<i>Viburnum edule</i> (Michx.) Raf.	lowbush cranberry
<i>Vicia americana</i> Muhl.	American vetch
<i>Viola adunca</i> J.E. Smith	early blue violet
<i>Viola canadensis</i> L.	western Canada violet
<i>Zizia aptera</i> (A. Gray) Fern.	heart-leaved Alexanders



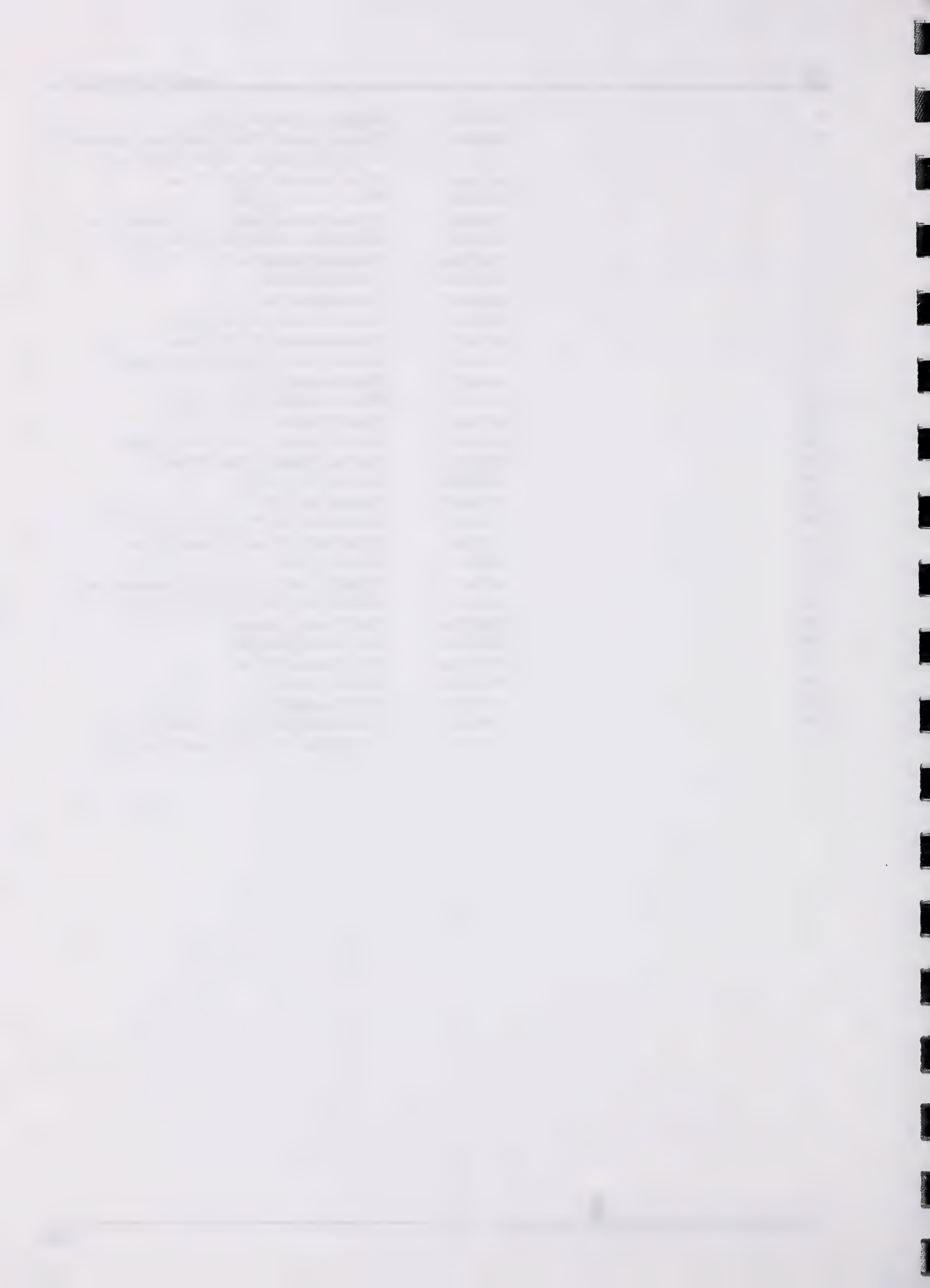
Appendix II

Lichens and Bryophytes found in Saskatoon Island Provincial Park

The species are listed by plot or location in which they were found.

Plot or location	Group	Species
Lagoon	Bryophytes	<i>Aulacomnium palustre</i> (Hedw.) Schwaegr.
Lagoon	Bryophytes	<i>Plagiomnium cuspidatum</i> (Hedw.) Kop.
Lagoon	Bryophytes	<i>Sanoinia uncinata</i> (Hedw.) Warnst.
old Amelanchier near S1	Lichens	<i>Melanelia subaurifera</i> (Nyl.) Essl.
old Amelanchier near S1	Lichens	<i>Physcia aipolia</i> (Ehrh. ex Humb.) Ffrrn.
S1	Bryophytes	<i>Eurhynchium pulchellum</i>
S1	Lichens	<i>Parmelia sulcata</i> Taylor
S1	Lichens	<i>Phaeophyscia rubropulchra</i> (Degel.) Moberg
S1	Lichens	<i>Xanthoria fallax</i> (Hepp in Arnold) Arnold
S2	Lichens	<i>Hypogymnia physodes</i> (L.) Nyl.
S2	Lichens	<i>Melanelia subaurifera</i> (Nyl.) Essl.
S2	Lichens	<i>Physcia adscendens</i> (Fr.) H. Olivier
S2	Lichens	<i>Physcia stellaris</i> (L.) Nyl.
S2	Lichens	<i>Usnea</i> cf. <i>scabrata</i>
S2	Lichens	<i>Xanthoria fallax</i> (Hepp in Arnold) Arnold
S3	Lichens	<i>Evernia mesomorpha</i> Nyl.
S3	Lichens	<i>Phaeophyscia rubropulchra</i> (Degel.) Moberg
S3	Lichens	<i>Physcia adscendens</i> (Fr.) H. Olivier
S3	Lichens	<i>Physcia aipolia</i> (Ehrh. ex Humb.) Ffrrn.
S3	Lichens	<i>Xanthoria fallax</i> (Hepp in Arnold) Arnold
SD7	Lichens	<i>Parmelia sulcata</i> Taylor
SD7	Lichens	<i>Physcia adscendens</i> (Fr.) H. Olivier
SD7	Lichens	<i>Physcia aipolia</i> (Ehrh. ex Humb.) Ffrrn.
SD7	Lichens	<i>Xanthoria fallax</i> (Hepp in Arnold) Arnold
T1	Bryophytes	<i>Brachythecium salebrosum</i>
T1	Bryophytes	<i>Lophozia ventricosa</i>
T1	Bryophytes	<i>Orthotrichum speciosum</i>
T1	Lichens	<i>Cladonia cornuta</i> (L.) Hoffm.
T1	Lichens	<i>Parmelia sulcata</i> Taylor
T1	Lichens	<i>Peltigera elisabethae</i> Gyelnik
T1	Lichens	<i>Usnea</i> cf. <i>scabrata</i>
T1	Lichens	<i>Xanthoria polycarpa</i> (Hoffm.) Rieber
T2	Bryophytes	<i>Ceratodon purpureus</i> (Hedw.) Brid.
T2	Bryophytes	<i>Hylocomnium splendens</i> (Hedw.) B.S.G.
T2	Bryophytes	<i>Plagiomnium cuspidatum</i> (Hedw.) Kop.
T2	Bryophytes	<i>Pleurozium schreberi</i> (Brid.) Mitt.
T2	Bryophytes	<i>Pohlia nutans</i> (Hedw.) Lindb.
T2	Bryophytes	<i>Tetraphis pellucida</i> Hedw.
T2	Lichens	<i>Cladonia chlorophaea</i> (Flörke ex Sommerf.) Sprengel
T2	Lichens	<i>Cladonia cornuta</i> (L.) Hoffm.
T2	Lichens	<i>Flavopunctelia flavescentior</i> (Stirton) Hale

T2	Lichens	<i>Hypogymnia physodes</i> (L.) Nyl.
T2	Lichens	<i>Peltigera didactyla</i> (With.) Laundon var. <i>extenuata</i> (Nyl. ex. Vainio) Goffinet & Hastings
T2	Lichens	<i>Physcia adscendens</i> (Fr.) H. Olivier
T2	Lichens	<i>Physcia stellaris</i> (L.) Nyl.
T2	Lichens	<i>Vulpicida pinastri</i> (Scop.) J.-E. Mattsson & Lai
T2	Lichens	<i>Xanthoria fallax</i> (Hepp in Arnold) Arnold
T3	Bryophytes	<i>Eurhynchium pulchellum</i>
T3	Bryophytes	<i>Pylaisiella polyantha</i>
T3	Lichens	<i>Parmelia sulcata</i> Taylor
T3	Lichens	<i>Peltigera membranacea</i> (Ach.) Nyl.
T3	Lichens	<i>Physcia adscendens</i> (Fr.) H. Olivier
T3	Lichens	<i>Xanthoria fallax</i> (Hepp in Arnold) Arnold
TD4	Lichens	<i>Parmelia sulcata</i> Taylor
TD4	Lichens	<i>Physcia adscendens</i> (Fr.) H. Olivier
TD4	Lichens	<i>Usnea</i> cf. <i>scabrata</i>
TD4	Lichens	<i>Xanthoria fallax</i> (Hepp in Arnold) Arnold
TD4	Lichens	<i>Xanthoria polycarpa</i> (Hoffm.) Rieber
TD5	Bryophytes	<i>Brachythecium salebrosum</i>
TD5	Bryophytes	<i>Pylaisiella polyantha</i>
TD5	Lichens	<i>Physcia adscendens</i> (Fr.) H. Olivier
TD5	Lichens	<i>Physcia aipolia</i> (Ehrh. Ex Humb.) Ffrrn.
TD5	Lichens	<i>Usnea</i> cf. <i>scabrata</i>
TD5	Lichens	<i>Vulpicida pinastri</i> (Scop.) J.-E. Mattsson & Lai
TD5	Lichens	<i>Xanthoria fallax</i> (Hepp in Arnold) Arnold
TD6	Bryophytes	<i>Brachythecium salebrosum</i>
TD6	Bryophytes	<i>Eurhynchium pulchellum</i>
TD6	Bryophytes	<i>Oncophorus wahlenbergii</i>
TD6	Bryophytes	<i>Pylaisiella polyantha</i>
TD6	Lichens	<i>Parmelia sulcata</i> Taylor
TD6	Lichens	<i>Physcia adscendens</i> (Fr.) H. Olivier
TD6	Lichens	<i>Xanthoria fallax</i> (Hepp in Arnold) Arnold



Appendix III

Percent cover for the dominant vascular plants

The percent cover of the 20 most dominant vascular plant species is given below.

	Shrub communities								Aspen communities							
	S1	S2	S3	S4	SD5	SD6	SD7	SD8	Average	T1	T2	T3	TD4	TD5	TD6	Average
AMELALN	80	40	90	50	30	95	2	70	57.13	45	30	70	1	50	3	33.17
ROSAACI	50	45	10	40	50	0	1	0	24.5	35	45	10	10	2	30	22
POPUTRE									0	75	70	50	35	50	80	60
EPILANG	12	0	15	1	3	0	2	5	3.5	5	1	5	0	5	1	2.83
HERALAN	25	0	25	1	1	25	50	25	19	0	0	5	2	1	0	1.33
SYMPSP	50	0	45	70	50	70	95	8	48.5	1	25	5	20	5	30	14.33
PRUNVIR	1	0	0	0	0	0	0	0	0.13	0	1	0	1	0	0	0.33
RIBEOXY	10	0	0	5	0	0	1	1	2.13	5	5	1	1	0	0	2
LATHOCH	1	0	0	0	0	0	0	0	0.13	0	0	0	0	0	0	0
GALIBOR	5	65	60	5	0	50	1	5	23.88	10	5	1	5	1	0	3.67
THALVEN	10	0	20	1	0	0	2	0	4.13	5	0	1	0	0	1	1.17
ACHIMIL	1	1	1	1	1	0	1	0	0.75	0	0	0	0	0	0	0
ASTECIL	1	15	0	0	3	0	0	0	2.38	0	0	0	0	0	0	0
ASTECON	0	0	0	0	0	0	0	5	0.63	0	0	30	10	20	0	10
LONIDIO	1	0	5	1	0	0	0	1	1	1	1	0	0	0	0	0.33
LONIINV									0	25	5	0	2	0	2	5.67
GRASSSP	5	85	15	30	10	0	0	0	18.13	55	10	40	5	0	0	18.33
CORNSTO									0	30	35	10	50	40	25	31.67
RUBUIDE	0	0	10	0	0	0	0	5	1.88	1	5	1	1	1	1	1.67
RUBUPUB									0	5	0	2	10	5	2	4

Mathematics

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Appendix IV

Ecological Inventory data sheets

Data sheets are on file at:
Alberta Environment
Natural Resources Service, Parks
Box 570
Valleyview, AB T0H 3N0

Mathematics

Mathematics

Mathematics

Mathematics

Appendix V

Tree Inventory data sheets

Data sheets are on file at:
Alberta Environment
Natural Resources Service, Parks
Box 570
Valleyview, AB T0H 3N0

Appendix V

Tree inventory data sheets

Tree sheet no. 01 to 10
African Environment
Nairobi Research Service, Kenya
Box 100
Nairobi AB 1011 2010



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